



GROUNDWATER MONITORING PLAN

Prepared for:

REFINED METALS CORPORATION
Beech Grove, Indiana

Prepared by:

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US EPA RECORDS CENTER REGION 5



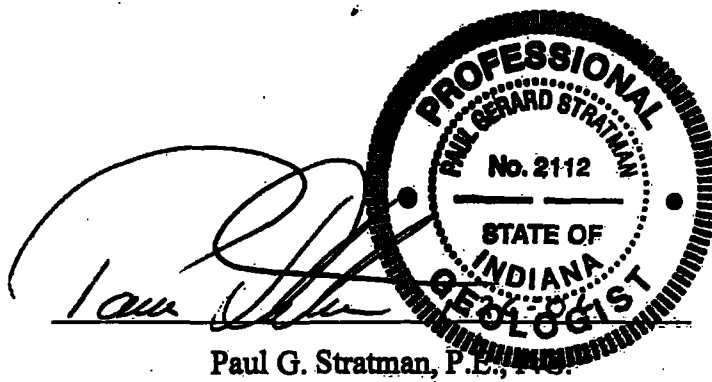
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1.0 INTRODUCTION

On July 14, 1998, Refined Metals Corporation (RMC) entered into a Consent Decree with the Indiana Department of Environmental Management (IDEM) and the United States Environmental Protection Agency (EPA) to settle complaints against RMC by IDEM and EPA regarding certain environmental matters at the RMC Facility located at 3700 Arlington Avenue, Beech Grove, Indiana (the "Site".) Section VI, Paragraph 37 of the Consent Decree requires that RMC close the onsite surface impoundment in accordance with the requirements of 40 C.F.R. Part 265, Subparts F and G, and 329 IAC 3.1-10-1(8). Among other things, these regulations require that, for the surface impoundment, a groundwater monitoring program must be in place to determine the surface impoundment's impact to groundwater. This Sampling and Analysis Plan (SAP) for Groundwater Monitoring (a.k.a. Groundwater Sampling Plan) specifies how groundwater in the vicinity of the Surface Impoundment will be monitored to meet this requirement. Site wide groundwater monitoring has been performed as part of the RCRA Facility Investigation which is being implemented through the EPA.



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2.0 SITE HISTORY

2.1 GENERAL SITE DESCRIPTION

The Site was the location of secondary lead smelting operations from 1968 through 1995. The location of the Site is shown on Figure 2-1. The Site ceased normal operations on December 31, 1995. The Site, as shown on Figure 2-2, covers approximately 24 acres which includes approximately 10 acres where smelting operations occurred. The remainder of the Site consists of areas of lawn and woods. The former smelter area contains several structures identified as the Battery Breaker, Material Storage and Furnace, Refining, Waste Water Treatment/Filter Press, and Office Buildings. Other smaller structures exist including a vehicle maintenance building, baghouses, and pump houses.

At this time, the Site is idle except for the storm water treatment system, which remains in operation to collect and treat storm water runoff from the lined lagoon and other site areas. The indoor and outdoor waste piles have been removed.

2.2 OPERATIONAL HISTORY

2.2.1 Operations

During its operating life, the facility handled materials, which were classified as hazardous materials or hazardous wastes under the Resource Conservation and Recovery Act (RCRA). These primarily consisted of lead bearing materials that were processed for lead recovery. In accordance with the requirements of RCRA, the facility completed and submitted a RCRA permit application. On November 19, 1980 the facility was granted approval to operate indoor and outdoor hazardous waste piles under Interim Status. Facility documents also identify a lined lagoon; however, it does not



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appear to have been included on the Facility Part A Permit Application until after 1991. The lagoon was, and still is used, to collect facility storm water runoff.

2.2.2 Smelting

The facility was constructed as a secondary lead smelter to recycle lead-acid batteries and other lead bearing wastes. Auto batteries constituted 90 percent of the materials recycled, and the remainder was waste material from battery manufacturers and other lead scrap. Prior to 1984, battery crushing was performed off-site at other commercial facilities. In 1984, the battery breaker was constructed on-site. The batteries were fed into the battery crusher where the tops of the batteries were sawed off and the sulfuric acid was collected in a sump and transferred into a stainless steel tank that drained to the wastewater treatment system. The battery casings and their contents were tumbled and crushed. Lead plates and other lead parts were separated and transported to waste piles to be later fed into the furnace. The battery casings were shredded and separated into plastic and ebonite in a flotation tank. The plastic was blown into a trailer for sale to an offsite recycler. Ebonite casings were placed in a separate waste pile and then fed into the blast furnace as a supplemental fuel.

2.2.3 Refining

Molten lead from the blast furnace was tapped from the bottom of the furnace to kettles in the adjacent refining and casting area. In the kettles, the molten lead was tested to determine its quality. Antimony and tin were either added or removed to create the required lead type and quality. Removal of antimony and tin was performed by adding sodium hydroxide or through oxidation. If the lead contained excess copper it was removed through the addition of red phosphorus. The excess antimony, tin, copper, and other impurities formed as dross on top of the molten lead and were removed through skimming. The dross was returned to the blast furnace. The refined lead was typically cast into 60-pound bars that were cooled, extracted and stacked for shipment off-site.



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3.0 SITE SETTING

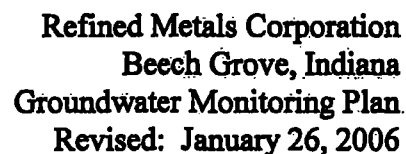
3.1 PHYSICAL SETTING

The Site is located in the White River Drainage Basin. The Site is situated on a minor local topographic high with a surface elevation of approximately 845 feet above mean sea level (msl). The surface elevation slopes gently to the southeast toward Sloan Ditch, and the northwestern perimeter of the Site slopes to the northwest toward the intermittent headwaters of Beech Creek. Surface water from within the former manufacturing areas of the Site is collected in the storm water management basin and is treated and discharged to the municipal sewer system.

Prior to construction of the present-day storm water collection and control system, surface water from the northern portion of the facility flowed to the intermittent stream that flows northwest to the headwaters of Beech Creek. Surface water from other areas on the Site historically flowed to the same location as the present-day (geomembrane lined) storm water basin, which was reportedly concrete lined. Water collected in this impoundment either evaporated, or when full, overflowed to a drainage ditch that flowed off-site to the east and then to the south, eventually discharging to Sloan Ditch. Sloan Ditch flows 0.6 mile west-southwest to Churchman Creek, which flows to the west 0.9 mile and discharges to Beech Creek. Beech Creek flows 1.2 miles to the southwest to Lick Creek, which then flows 7 miles to the White River.

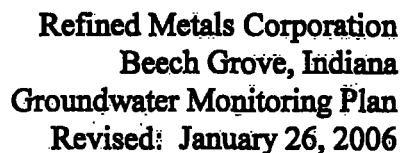
3.2 REGIONAL GEOLOGY AND HYDROGEOLOGY

The surficial geology of Marion County is glacial till (Tipton Till Plain) consisting of yellowish-gray, bluish-gray, or gray sand or silt with some clay and pebbles and scattered cobbles and boulders. The drift cover in Marion County is believed to be composed of three drift sheets resulting from the Kansan, Illinoian, and Wisconsin glaciations. Till thicknesses range from less than 15 feet to greater



Regionally, groundwater is encountered in un-named sand and gravel beds overlying the bedrock, the Jefferson Limestone and Geneva Dolomite, and the Niagaran Limestones (Harrison, 1963). The sand and gravel glacial outwash that coincides with the courses of the White River and Fall Creek is the aquifer of greatest economic importance in Marion County. The location of this aquifer generally coincides with the glacial melt water and outwash deposits along the major streams. Fall Creek enters White River upstream of the Site. The White River sand and gravel aquifer is located approximately 5.3 miles west of the Site. The sand and gravel aquifer is unconfined and flows toward and discharges to the surface water bodies. The hydraulic conductivity was determined for sand, sand and gravel, and gravel by Meyer, 1975 and is as follows:

Sand	40 ft/day
Sand and Gravel	240 ft/day
Gravel	415 ft/day



Four deep borings identified as MW-1D, MW-2D, MW-3D and MW-6D were advanced on-site to depths ranging from 110 feet to 130 feet bgs during the Phase I RFI to characterize subsurface conditions. Borings MW-2D and MW-6D were subsequently converted into monitoring wells as discussed below. The logs for these four deep borings are attached in Appendix A. Stratigraphy typically varies from clayey silt to sandy silt, occasionally grading into a clay or sand. When encountered, zones of clay or sand were generally thin and laterally discontinuous. The only notable exception was a clay layer encountered in all four deep borings that ranged in thickness from 7 to 12 feet at depths between 50 and 60 feet below ground surface (bgs). A second clay zone was encountered in each of the deep borings at depths typically between 90 and 100 bgs. The thickness of the till plain beneath the Site is at least 110 to 130 feet as bedrock was not encountered in any of the deep borings.

Shallow groundwater encountered at the Site is believed to represent a local perched zone of saturation in sand layers within the glacial till. AGC reviewed the logs of the four deep and six shallow borings advanced during the RFI and CMS, and the five shallow boring logs advanced prior to installation of site monitoring wells MW-1 through MW-5 in 1991 (see Appendix A). The boring logs indicate that the sand layers vary in thickness and elevation throughout the Site. The piezometric surface for the shallow on-site wells for three sampling events is provided as Figures 3-1 (September, 2001), 3-2 (December, 2001) and 3-3 (October, 2003). As show, groundwater flow in the shallow on-site wells appears to be to the southeast beneath the former manufacturing areas (an area covered with buildings and pavement) and towards the east-northeast beneath the areas north of the former manufacturing area. The piezometric surface for the shallow perched groundwater on-site



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is less than 5 feet bgs. Southeast of the former manufacturing area, shallow groundwater flow heads due south. The change in flow appears to be the result of greater amounts of infiltration occurring in the poorly drained grass areas between Arlington Avenue and the former manufacturing area. The area in the general vicinity of MW-11 will typically have standing water.

Boring logs for the deep borings on-site indicate that a substantial thickness of silt and clay is deposited below the shallow zone of saturation. The deep wells completed on-site for the Phase I RFI (MW-2D and MW-6D) were set in a middle perched zone located 75 to 85 feet below grade. It should be noted that these borings were advanced to 110 and 123 feet below grade. The other two deep borings (MW-1D and MW-3D) did not encounter a distinct middle perched zone, although both borings were advanced to a final depth of 130 feet bgs, as specified in the Phase I RFI Work Plan. The regional uppermost semi-confined aquifer was not encountered in any of the deep borings.



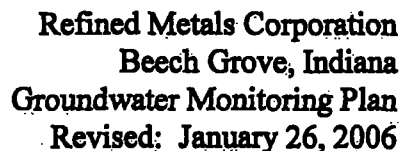
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4.0 SUMMARY OF PREVIOUS GROUNDWATER SAMPLING

4.1 GENERAL

Two groundwater sampling events were performed as part of the Phase I RFI. The wells sampled during the Phase I RFI included five original wells, MW-1 through 5, screened in the shallow perched zone, one shallow well, MW-6, and two deeper wells screened in the middle perched zone, MW-2D and MW-6D. Groundwater samples from both events were analyzed for 8 RCRA metals and antimony. The first groundwater sampling event (September 1999) also included laboratory analysis for 1,1,1-Trichloroethane, tetrachloroethene, benzene, toluene and ethylbenzene. Subsequent VOC analysis was not required because all results were below the 1 µg/L limit of quantitation. Results of the VOC analysis are provided on Table 4-16.

Two additional rounds of groundwater sampling were performed during Phase II RFI investigation activities which also included the installation of three additional shallow wells, MW-7, 8, and 9. A fifth groundwater sampling event was performed during October 2003, which also included the installation of two more shallow wells, MW-10 and 11. The sampling results are provided in Tables 4-1 through 4-14. Groundwater samples from the third through fifth sampling events were analyzed for the 8 RCRA metals and antimony. A Surface Impoundment specific groundwater sampling event was performed in April 2005 which also included the installation of MW-12. The April 2005 samples were analyzed for the 8 RCRA metals and antimony. Table 4-15 provides a summary of previous sample results for well MW-12.



This summary of groundwater sampling results includes all of the inorganic analytical results for groundwater samples collected from the Surface Impoundment wells since the beginning of the RFI. The proposed Surface Impoundment wells are MW-5, MW-6S (a.k.a. MW-6SR), MW-9 (upgradient) and MW-12. As shown, this includes the results of up to six sampling events. The results may be summarized as follows:

Antimony analysis was performed on 12 filtered and 17 unfiltered samples from wells monitoring the shallow perched groundwater zone. The method detection limit (MDL) for analysis established in the RFI Work Plan was 10 µg/l for all sampling events except the April 2005 event when the MDL was 1 µg/l. Antimony was never detected at or above the MDL. The Region IX Preliminary Remediation Goal (PRG) for tap water is 15 µg/l. The IDEM default value for residential groundwater is 6 µg/l. Because all the values were non-detect no statistical evaluation was performed.

Arsenic analysis was performed on 12 filtered and 17 unfiltered samples from wells monitoring the shallow perched groundwater zone. The method detection limit for all analysis was 1.0 µg/l. Arsenic was detected in nearly every sample analyzed, including the well designated as the upgradient well (MW-9.) The Region IX Preliminary Remediation Goal (PRG) for arsenic in tap water is 0.045µg/l. The IDEM default value for arsenic in residential groundwater is 50 µg/l. A statistical evaluation of arsenic using Student's t-test at a level of freedom of 0.01 determined that



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there is no statistical difference between the upgradient and downgradient wells. Additionally, no results exceed the IDEM RISC Residential Default value of 50 mg/l.

Lead

Lead analysis was performed on 12 filtered and 17 unfiltered samples from wells monitoring the shallow perched groundwater zone. The method detection limit for lead analysis was 1.0 µg/l. Lead was detected in 10 of the 17 unfiltered samples and 1 of the 12 filtered samples. The IDEM default value for lead in residential groundwater is 15 µg/l. One unfiltered sample (MW-6 September 1999) exceeded 15 µg/l with a result of 21 µg/l. Well MW-6 was reconstructed following the December 1999 sampling event because of low yield that prevented the use of low flow sampling techniques. The highest observed total lead value since reconstruction is 2.7 µg/l. USEPA Region IX does not list a PRG for lead in tap water. A statistical evaluation of lead was performed using Student's t-test at a level of freedom of 0.01. That evaluation determined that there is no statistical difference between the upgradient and downgradient wells. A copy of the statistical analysis is provided as Appendix C.

Other Metals

Other metals analyzed during the RFI groundwater sampling were cadmium, barium, chromium, mercury, selenium, and silver. No exceedances of the corresponding values under the IDEM default residential or Region IX tap water PRGs were observed for these compounds. Additionally, the statistical evaluation determined that there is no significant difference between upgradient and downgradient wells.



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that might be present based on historic operations. These VOCS included 1,1,1-trichloroethane, tetrachlorethene, benzene, toluene, and ethylbenzene. During the RFI, all monitoring wells were sampled for these VOCs and none were detected. Therefore, analysis for any VOCs is not warranted. Sampling equipment and method procedures are present in Section 6.0 and in Appendix B. Sample analysis methods are present in Section 7.0 and the QAPP. All sampling methods and analysis will be performed in accordance with the protocol and quality assurance procedures described in the the QAPP. Analysis will include filtered and unfiltered samples to allow clarification and understanding of contribution by suspended solids (un-filtered results minus filtered results) versus actual water quality (filtered results).

Analytical data packages will be reviewed and validated by an AGC data validator as described in the QAPP. The validated results will be analyzed as described in Section 7.4. On or before March 1 of every year, the results of the sampling for the previous year will be submitted to the IDEM in an Annual Groundwater Assessment Report both in a paper and electronic format. The results will include a groundwater contour map for depth to water measurements taken at the time of sampling, a table of results specific to the sampling event, and a summary table on a well by well basis.

As described in Section 7.4, comparisons of upgradient and downgradient results will be performed using Student's t-test at the 0.01 level of significance over initial background. As discussed in Section 4.0, the statistical evaluation performed during preparation of this plan indicated no significant difference between the upgradient and downgradient wells. A copy of the statistical evaluation is provided in Appendix C. Section 7.4.2 describes what measures will be taken if a statistically significant result is identified.



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6.0 SAMPLING EQUIPMENT AND PROCEDURES

6.1 SAMPLING EQUIPMENT

The following section outlines the sampling equipment required for the groundwater sampling at the Site. In addition to the itemized groundwater sampling equipment, a copy of this SAP for Groundwater Monitoring shall be present at the well head when sampling is performed.

6.1.1 Groundwater Sampling Equipment

The following equipment will be used for the groundwater monitoring wells sampling:

- Low-flow bladder pump and control box;
- Flow through cell;
- Generator and/or nitrogen tank;
- Laboratory supplied containers for the collection of metals samples;
- Ice cooler for sample storage and transport;
- Ice;
- pH/temperature meter;
- Conductivity meter;
- Depth to water meter;
- Interface probe;
- Teflon[®] tubing; and,
- Disposable bailers.

6.2 GROUNDWATER SAMPLING PROCEDURES

The following sections describe groundwater sampling procedures. The groundwater monitoring well sampling is comprised of synoptic water level measurements, field analysis, well purge techniques, sample collection, and decontamination procedures as described in more detail below. Groundwater sampling will begin at MW-9, the designated up-gradient monitoring well, then proceed to the next selected well with the lowest historical total metal concentration.

6.2.1 Synoptic Water Levels

Prior to all groundwater sampling events, depth-to-water will be measured in each well (MW-1, MW-2, MW-2D, MW-3, MW-4, MW-5, MW-6, MW-6SR, MW-7, MW-8, MW-9, MW-10, MW-11 and MW-12) using an electronic water level indicator. The synoptic measurements will include the measurement of water levels and well depths in the monitoring wells in as short a time frame as possible to determine the piezometric surface across the Site. The field personnel will measure the water levels in the wells to the nearest 0.01 foot using the surveyed point at the top of the inner well casing for reference. Measurements will be repeated at each well until two consecutive readings are within 0.01 feet. Total depths will also be measured in each well after (to avoid suspension of settled solids) each sampling event to evaluate whether any silting of the well has occurred between sampling rounds. Water levels measurements will be collected following IDEM Guidance Documents titled for Collecting Static Water Level Measurements and Developing Ground Water Flow Maps.

6.2.2 Field Analyses.

Field measurements that will be performed during well purging will include pH, specific conductivity, temperature, oxidation/reduction potential (ORP), dissolved oxygen (DO), and

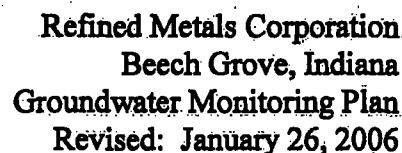


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turbidity. Measurements will be collected by inserting the appropriate probe in a closed non-dedicated plastic container (flow-through-cell) that is rinsed with deionized water prior to purging the well. Turbidity samples will be collected from the flow through cell outflow.

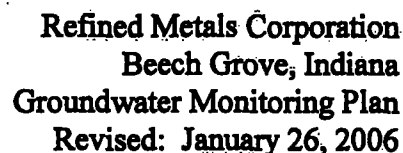
Calibration of the instruments will be completed at the beginning of each sampling day, checked in the middle of the day, and as otherwise necessary based on the functioning of the meters and equipment. Each meter will be field calibrated in accordance with the manufacturer's specifications and appropriate calibration solutions. All calibrations will be recorded in the field log. Field calibration procedures at a minimum will include the following:

- Calibration of the field instruments will be performed by trained technicians prior to the mobilization of equipment to the Site. All the instruments will be calibrated as specified by the manufacturer. Standard solutions will also be checked to determine stability and operating conditions. All results of field calibrations and measurements will be maintained in bound field logbooks at least daily when the instrument is in use. The recorded calibration information will include date and time of calibration results.
- pH meters will be calibrated according to the manufacturer's instructions prior to each use and will, at a minimum, consist of two standard buffer solutions (pH 4, 7, or 10) obtained from chemical supply houses. The pH values of the buffers will be compensated for the temperature at which the pH sample is measured. Verification checks will be completed at least once per day using a standard solution. The verification check results must agree within ± 0.05 pH standard units or recalibrations will be performed.

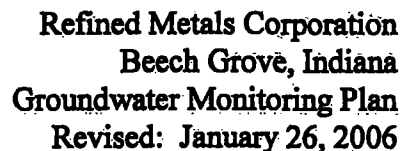


- All calibration procedures performed will be documented in the field logbook and will include the date and time of calibration, name of the person performing the calibration, reference standards used and instrument readings. If equipment fails calibration or equipment malfunction is noted during calibration or use, the equipment will be tagged and removed from service.

Sampling procedures will include water level measurements, calculation of well volumes, purging, and sampling activities. The following step-by-step procedures are in adherence to the EPA Region IX groundwater sampling protocols for low flow pump purging and sampling, which are based upon



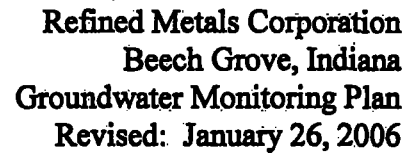
Step 7 After conductivity and temperature have stabilized to within 3% over three readings, pH readings differ < 0.1 standard pH units, ORP readings differ within 10 mV, and turbidity measurements differ within $\pm 10\%$, sampling can begin after the flow-through cell is disconnected.



Step 9 Using the well purging pump, the flow rate will remain at 100 ml/min and a disposable 0.45 micron in-line filter will be place at the discharge line. The filtered sampled collected at the discharge end of the in-line filter. The date and time of the sample collection will be recorded in the field logbook. Filtering the samples in-line, as proposed, with disposable filters will reduce sample agitation, exposure to the atmosphere, and decontamination concerns.

Purge water will be collected and containerized in a drum. The pump and sampling equipment will be decontaminated before and between each well.

Groundwater samples will be collected using the low flow pump or peristaltic pump and tubing at a rate of 100 ml/min with the flow-through cell disconnected. Groundwater will be collected directly into laboratory prepared bottles. As per the QAPP Table 4-1, filtered groundwater samples will be collected in two-liter HDPE bottles that are preserved with nitric acid to a pH value of less than 2 standard units. Unfiltered samples will also be collected in two-liter HDPE bottles with no preservation. Immediately following sample collection and labeling of bottle, the sample will be placed in an ice cooler to maintain sample at 4° C.



The pump will be disassembled and components will be decontaminated in the following manner:

- To prevent possible contamination from sampling equipment, all non-dedicated sampling devices will be decontaminated. Non-dedicated equipment is the low flow pump. Sampling equipment will be constructed of inert material (e.g., stainless, Teflon®). For non-dedicated equipment, field decontamination will be performed prior to its initial use, between sampling locations and between actual samples when more than one sample is to be collected at a given location. Decontamination is not required when subsequent use of decontaminated equipment will be documented in a field logbook. All non-dedicated sampling equipment will be decontaminated according to the following procedure:

1. Wash equipment thoroughly with a low phosphate detergent (Alconox) and water using a brush to remove any particulate matter or surface film.
2. Rinse equipment with distilled water.
3. Rinse with diluted metric acid (10%N).
4. Triple rinse with distilled water.
5. Air dry equipment.



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7.0 SAMPLE HANDLING AND ANALYSIS

All sample bottles will be identified by the use of sample labels with the sample identification. Each sample label will be filled out by the sampler to avoid any possibility of sample misidentification and attached to the sample container. Indelible ink shall be used to complete the sample labels. Each sample label will be labeled at the time of collection with, at a minimum, the following information:

- Sample identification;
- Initials of the sample collector;
- Time and date of the sample collection;
- Site name and location number (if any);
- Requested analyses;
- Any preservative added or field preparation performed; and,
- Sample designation if this sample is a quality assurance sample.

Each member of the sampling team will use a new pair of gloves at each sample location.

The field sampler will maintain custody of the samples following the procedures outlined in the following sections until the samples are properly relinquished to the laboratory or a common carrier for delivery to the laboratory. Once at the laboratory, each sample will be assigned a unique laboratory identification number that will be used for analysis assignment, sample tracking, and data reporting while the samples are at the laboratory.

7.1 SAMPLE CUSTODY/SAMPLE CONTROL

A sample is physical evidence collected from the Site. Due to the evidentiary nature of the data generated from sampling, sample custody must be traceable from the time the empty sample



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containers are prepared by the laboratory through the reporting of the results of the analyses. Therefore, sample control procedures have been established to ensure sample integrity. All sample containers and samples will be maintained under strict custody procedures throughout the investigation. Sample custody is addressed in three parts: field sample collection, laboratory analysis, and final evidence files.

A sample, sample container, or evidence file will be considered under custody if:

- An item is in the actual possession of the person; or
- The item is in the view of the person, after being in actual possession of the person;
or
- The item was in the person's actual physical possession but is now locked up or sealed in a tamper-proof manner; or
- The item is placed in a designated secured restricted area.

7.1.1 Field Custody Procedures

The field personnel in charge of collecting the samples will maintain custody of the samples collected. The field personnel will be responsible for documenting each sample transfer and maintaining custody of all samples until they are shipped to the laboratory or archived. All samples will be stored on ice and shipped to the laboratory in iced coolers.

7.1.2 Field Data Documentation/Field Logs

A system of logging all pertinent data collected during sampling operations will be maintained using a dedicated field logbook(s). Each page will be numbered, dated and initialed by the person making the entry. All entries will be made in indelible ink. Incorrect entries will be crossed out with a single



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line and verified with the recorder's initials. At the completion of the day, if a page is not complete, a diagonal line will be drawn through the remainder of the page with the recorder's signature at the bottom.

All sample locations will be recorded and referenced to the site map so that each location is permanently established. Samples will be tagged with all pertinent site information at the time of sampling. Pertinent site information to be supplied in the field logbook for each task is listed below:

- Signature of recorder;
- Name and location of sample (i.e., EA, monitoring well, etc.);
- Date and time of arrival and departure;
- Names of all personnel on-site and their affiliation;
- Purpose of the visit/description of the field activity;
- All field instruments used, date and time of calibration and calibration checks, method of calibration, and standards used;
- All field measurement results;
- Date, time, and location of all sampling;
- Method of sample collection;
- Any factors which could affect sample integrity;
- Name of sampler(s);
- Sample identification, sample description, and sample preservation;
- Documentation of all conversations with the client, agency personnel, field decisions and approval; and,
- Weather conditions.



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- **Analysis required;**
- **Type of preservative;**
- **Signatures of individuals involved in sample transfer (i.e., relinquishing and accepting samples). Individuals receiving the samples shall sign, date, and note the time they received the samples/cooler on the record; and,**
- **Type of carrier service.**

The original chain-of-custody record will accompany the sample containers during transport to document their custody.

- **If custody is relinquished through a common carrier for delivery to the laboratory, the following protocol will be followed:**
 - **In the space for the sample receiver, the name of the common carrier and the date relinquished will be written. In addition, if known, the tracking number will be included on the chain-of-custody record.**
 - **The original completed chain-of-custody record will be placed inside the shipping package; and,**
 - **The shipping package will be sealed with tape and custody seals affixed. The seals will be placed on the package in such a manner that the package cannot be opened without breaking the seals. The seals will serve to document that the shipping container was not opened during the shipment through the common parcel carrier.**

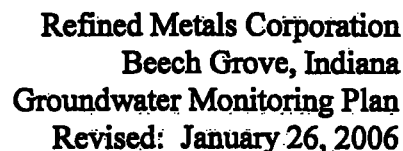


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7.1.4 Sample Shipment Procedures

At the end of each sampling day, all samples for chemical analysis will be packaged in shipping containers for shipment to the analytical laboratory using the following steps:

1. Check each sample bottle for a properly completed sample identification label.
2. Place the sample bottles from each location in separate plastic bags, and then seal.
3. Ship the samples in a large capacity (waterproof metal or plastic) cooler, or specific laboratory prepared sample-shipping container. Place packing material on the bottom of the cooler to prevent sample bottle breakage.
4. Place the sample bottles in the shipping container in a manner such that they do not touch and will not touch during shipment. Secure with packing material as needed to fill void space.
5. Maintain all samples at $4^{\circ}\text{C} \pm 2^{\circ}\text{C}$ during shipment. Use ice to cool the samples.
6. Place the original chain-of-custody record in a plastic bag, seal, and tape it to the inside of the shipping container lid.
7. Retain the pink copy of the chain-of-custody for the AGC QA Manager.
8. Tape the cooler drain shut. Tape the cooler or shipping container closed at a minimum of two locations.
9. Place two signed and dated custody seals across each edge of the shipping container.
10. Attach the completed shipping label to the top of the shipping container.
11. Relinquish the cooler to the courier with the required signed and dated handbill/waybill.
12. Retain receipt of the handbill/waybill as part of the permanent documentation.



7.2 QUALITY ASSURANCE/QUALITY CONTROL SAMPLING

Equipment Blanks – Equipment blanks will be collected to ensure that the sampling equipment is clean and that the potential for cross-contamination has been minimized. One equipment blank will be collected per day or for every ten (10) samples per day (whichever is more frequent) when sampling equipment is decontaminated. The equipment blank will be collected by pouring ultra-pure deionized water (laboratory grade) into the decontaminated sampling equipment (e.g., low flow bladder pump or stainless steel pan) and then transferring the rinsate from the equipment into the appropriate sample containers. The equipment blank will be analyzed for the identical parameters as the samples.

Matrix Spike Samples – Site specific MS samples will be submitted to the laboratory for quality control checks. The samples will be collected at the frequency of one MS for every ten (10) samples. These MS quality control (QC) samples will allow for the accuracy to be determined by the recovery rates of the compounds. The MS sample aliquots will be acquired for each matrix by providing triple the necessary sample volume for the location selected.



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Field Duplicate Samples – A blind field duplicate sample will be collected to allow for the determination of sampling precision of the sampler and the analytical laboratory. One field duplicate sample will be collected for every ten (10) samples and submitted for analysis of the identical parameters as the original sample.

7.3 **ANALYTICAL PARAMETERS AND TEST METHODS**

Trimatrix of Grand Rapids, Michigan will perform all analyses in accordance with the accepted USEPA *SW-846 Test Methods for Evaluating Solid Wastes: Physical/Chemical Properties (April 1998, revision 5)* methods.

The groundwater will be analyzed for antimony, arsenic, lead, and manganese by SW-846 Methods 3010A/6020, iron and sodium by SW-846 Methods 3010A/6010B, and chloride and sulfate by MCAWW325.2 and MCAWW375.2, respectively.

Analysis will include filtered and unfiltered samples to allow clarification and understanding of contribution by suspended solids (un-filtered results minus filtered results) versus actual water quality (filtered results).

Analytical data packages will be reviewed and validated by an AGC data validator as described in the QAPP. Following validation, the results will be submitted to the IDEM both in a paper and electronic format. The results will include a groundwater contour map for depth to water measurements taken at the time of sampling; a table of results specific to the sampling event; and a summary table on a well by well basis.



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7.4 ANALYSIS AND REPORTING

7.4.1 Statistical Analysis

A statistical analysis will be performed when new validated data is received. The analysis will compare the results for the upgradient well with results for the downgradient wells. The comparison will be performed on a well by well basis for each parameter. Where appropriate, the analysis will be performed using Student's t-test for a level of significance of 0.01. If the data set contains greater than 50% of the samples with equal results, the analysis will be performed using the Mann-Whitney U-Test. Use of the Mann-Whitney is most appropriate in this type of a situation and a common substitute for the Student's t-test.

7.4.2 Additional Sampling and Response

Pursuant to the requirements of 40 cFR 265.93(d), if the results of the statistical analysis indicate a significant increase in one of the parameters being evaluated, a subsequent round of sampling will be performed for the well in question. The new sample will be split. If the subsequent sampling determines that the previous result was erroneous, then routine monitoring will resume. If the subsequent sampling determined that a significant increase is present then written notice will be provided to IDEM within seven (7) days of such confirmation. The written notice will include a request to meet with IDEM to review the results and discuss the next appropriate action. If the results in question exceed the IDEM RISC Industrial Default Closure Tables for Groundwater then RMC will submit a plan specifying additional activities required to evaluate the observed condition. If those additional measures include the installation of additional groundwater monitoring wells, they shall be installed in accordance with the procedures provided in RCRA Facility Investigation Work Plan.



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7.4.3 Annual Groundwater Assessment Report

An Annual Groundwater Assessment Report (AGAR) will be prepared and submitted to the IDEM by March 1 of each year. The AGAR will include the historic groundwater sampling information for the monitoring wells used to evaluate the Surface Impoundment, through and including the data generated during the previous calendar year. The compiled information will be presented in tabular format.

7.5 CLOSURE DEMONSTRATION

At the present time, the results of statistical analysis (Student's t-test) performed on the groundwater monitoring wells immediately downgradient of the Surface Impoundment show that there has been no impact to groundwater from the Surface Impoundment. If the results of the subsequent sampling continue to show "no impact" to groundwater by the Surface Impoundment, then no additional demonstration will be necessary and quarterly monitoring will cease when removal of the Surface Impoundment is complete.

If subsequent sampling does show possible impact, then it is expected that groundwater closure will be demonstrated following "Default Closure Option 2" contained in the IDEM RISC Technical Guidance. This will require a demonstration (performed utilizing 8 consecutive quarters of groundwater monitoring) that the observed concentrations are below the closure level established for groundwater at the Surface Impoundment. To date, none of the IDEM RISC Residential Groundwater Default Closure values has been exceeded in any of the wells used to monitor the Surface Impoundment when sampled using low flow sampling techniques.



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TABLES

TABLE 4-1
SUMMARY OF ALL SHALLOW WELL GROUNDWATER RESULTS
 Refined Metals Corporation
 Beech Grove, Indiana

Parameter		IDEM Residential Default RISC Criteria (µg/L)	USEPA Region 9 Tap Water PRGs (µg/L)	Total Number of Samples	Total Number of Detections	Total Number of Exceedances*
Antimony	Dissolved	6	15	26	0	22
	Total	6	15	45	1	41
Arsenic	Dissolved	50	0.045	26	21	0
	Total	50	0.045	45	42	1
Barium	Dissolved	2000	2600	26	26	0
	Total	2000	2600	45	45	0
Cadmium	Dissolved	5	18	26	1	0
	Total	5	18	45	7	0
Chromium	Dissolved	100	110	26	21	0
	Total	100	110	45	19	0
Lead	Dissolved	15	NC	26	7	1
	Total	15	NC	45	27	10
Mercury	Dissolved	2	11	6	1	0
	Total	2	11	45	0	0
Selenium	Dissolved	50	180	26	7	0
	Total	50	180	45	15	0
Silver	Dissolved	182.5	180	6	0	0
	Total	182.5	180	45	0	0

NC - USEPA Region 9 does not have a tap water PRG for lead.

* Exceedance of the IDEM Residential Default RISC criteria.

The results summarized are from groundwater sampling events performed by AGC following the RCRA Facility Work Plan.



TABLE 4-2
SUMMARY OF GROUNDWATER RESULTS
Well MW-1
Refined Metals Corporation
Beech Grove, Indiana

Parameter		IDEM Residential Default RISC Criteria (µg/L)	USEPA Region 9 Tap Water PRGs (µg/L)	Sampling Events				
				9/21/1999	12/14/1999	9/22/2001	12/10/2001	10/27/2003
Antimony	Dissolved	6	15	--	--	--	10 U	10 U
	Total	6	15	10 U	10 U	10 U	10 U	10 U
Arsenic	Dissolved	50	0.045	--	--	--	22 J	21
	Total	50	0.045	21	25	33	27	24
Barium	Dissolved	2,000	2,600	--	--	--	85	69
	Total	2,000	2,600	96	86	101	93	69
Cadmium	Dissolved	5	18	--	--	--	0.2 U	0.2 U
	Total	5	18	0.2 U	0.2 U	0.2	0.2 U	0.2 U
Chromium	Dissolved	100	110	--	--	--	8.9 J	6.5
	Total	100	110	1.8 U	1 U	3.1	4	1.3
Lead	Dissolved	15	NC	--	--	--	1 U	1 U
	Total	15	NC	1.8 U	1 UJ	5.9	3.4	1 U
Mercury	Total	2	11	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Selenium	Dissolved	50	180	--	--	--	4.9 J	2 U
	Total	50	180	9	7.3	6.1 J	4	2 UJ
Silver	Total	182.5	180	0.2 R	0.2 UJ	0.2 UJ	0.2 U	0.2 U

NC - USEPA Region 9 does not have a tap water PRG for lead.

-- The sample was not analyzed for dissolved metals

Shading indicates the exceedance of the IDEM Residential Default RISC criteria.

Qualifiers: U - not detected; J - estimated; R - rejected; UJ - not detected, estimated reporting limit

The results summarized are from groundwater sampling events performed by AGC following the RCRA Facility Work Plan.



TABLE 4-3
SUMMARY OF GROUNDWATER RESULTS
Well MW-2
Refined Metals Corporation
Beech Grove, Indiana

Parameter		IDEM Residential Default RISC Criteria (µg/L)	USEPA Region 9 Tap Water PRGs (µg/L)	Sampling Events				
				9/21/1999	12/15/1999	9/22/2001	12/10/2001	10/27/2003
Antimony	Dissolved	6	15	—	—	—	10 U	10 U
	Total	6	15	10 U	10 U	10 U	10 U	10 U
Arsenic	Dissolved	50	0.045	—	—	—	9.8 J	10
	Total	50	0.045	9.8	15	12	12	15
Barium	Dissolved	2,000	2,600	—	—	—	25	22
	Total	2,000	2,600	40	45	31	48	44
Cadmium	Dissolved	5	18	—	—	—	0.2 U	0.2 U
	Total	5	18	0.2 U	0.2	0.3	0.4	0.2
Chromium	Dissolved	100	110	—	—	—	6.8 J	3.1
	Total	100	110	1 U	1.6	1 U	4.8	2.1
Lead	Dissolved	15	NC	—	—	—	6.2	2.9
	Total	15	NC	11	18	49	84	44
Mercury	Total	2	11	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Selenium	Dissolved	50	180	—	—	—	3.7 J	2 U
	Total	50	180	7.7	6	2 U	3.1	2 UJ
Silver	Total	182.5	180	0.2 R	0.2 UJ	0.2 UJ	0.2 U	0.2 U

NC - USEPA Region 9 does not have a tap water PRG for lead.

-- The sample was not analyzed for dissolved metals

Shading indicates the exceedance of the IDEM Residential Default RISC criteria.

Qualifiers: U - not detected; J - estimated; R - rejected; UJ - not detected, estimated reporting limit

The results summarized are from groundwater sampling events performed by AGC following the RCRA Facility Work Plan.



TABLE 4-4
SUMMARY OF GROUNDWATER RESULTS
Well MW-2D
Refined Metals Corporation
Beech Grove, Indiana

Parameter		IDEM Residential Default RISC Criteria (µg/L)	USEPA Region 9 Tap Water PRGs (µg/L)	Sampling Events	
				9/21/1999	12/15/1999
Antimony	Dissolved	6	15	--	--
	Total	6	15	10 U	10 U
Arsenic	Dissolved	50	0.045	--	--
	Total	50	0.045	6.3	15
Barium	Dissolved	2,000	2,600	--	--
	Total	2,000	2,600	334	311
Cadmium	Dissolved	5	18	--	--
	Total	5	18	0.2 U	0.2 U
Chromium	Dissolved	100	110	--	--
	Total	100	110	5.2	1 U
Lead	Dissolved	15	NC	--	--
	Total	15	NC	10	3.1 J
Mercury	Total	2	11	0.2 U	0.2 U
Selenium	Dissolved	50	180	--	--
	Total	50	180	2 U	2 U
Silver	Total	182.5	180	0.2 R	0.2 UJ

NC - USEPA Region 9 does not have a tap water PRG for lead.

-- The sample was not analyzed for dissolved metals

Shading indicates the exceedance of the IDEM Residential Default RISC criteria.

Qualifiers: U - not detected; J - estimated; R - rejected; UJ - not detected, estimated reporting limit

The results summarized are from groundwater sampling events performed by AGC following the RCRA Facility Work Plan.



TABLE 4-5
SUMMARY OF GROUNDWATER RESULTS
Well MW-3
Refined Metals Corporation
Beech Grove, Indiana

Parameter		IDEM Residential Default RISC Criteria (µg/L)	USEPA Region 9 Tap Water PRGs	Sampling Events				
				9/22/1999	12/14/1999	9/22/2001	12/11/2001	10/26/2003
Antimony	Dissolved	6	15	—	—	—	10 U	10 U
	Total	6	15	10 U	10 U	10 U	10 U	10 U
Arsenic	Dissolved	50	0.045	—	—	—	8.4 J	7.5
	Total	50	0.045	11	7.8	9.7	11	28
Barium	Dissolved	2,000	2,600	—	—	—	113	73
	Total	2,000	2,600	135	127	102	98	84
Cadmium	Dissolved	5	18	—	—	—	0.2 U	0.2 U
	Total	5	18	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Chromium	Dissolved	100	110	—	—	—	6.6 J	4.9
	Total	100	110	1.1	1 U	1 U	1 U	1 U
Lead	Dissolved	15	NC	—	—	—	1 U	1 U
	Total	15	NC	1 U	1 UJ	1.3	1 U	1 U
Mercury	Total	2	11	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Selenium	Dissolved	50	180	—	—	—	3.7 J	2
	Total	50	180	5.2	5.3	2 U	3.7	2 UJ
Silver	Total	182.5	180	0.2 R	0.2 UJ	0.2 UJ	0.2 U	0.2 U

NC - USEPA Region 9 does not have a tap water PRG for lead.

— The sample was not analyzed for dissolved metals

Shading indicates the exceedance of the IDEM Residential Default RISC criteria.

Qualifiers: U - not detected; J - estimated; R - rejected; UJ - not detected, estimated reporting limit

The results summarized are from groundwater sampling events performed by AGC following the RCRA Facility Work Plan.



TABLE 4-6
SUMMARY OF GROUNDWATER RESULTS
Well MW-4
Refined Metals Corporation
Beech Grove, Indiana

Parameter		IDEM Residential Default RISC Criteria (µg/L)	USEPA Region 9 Tap Water PRGs (µg/L)	Sampling Events				
				9/22/1999	12/14/1999	9/24/2001	12/11/2001	10/26/2003
Antimony	Dissolved	6	15	--	--	--	10 U	10 U
	Total	6	15	10 U	10 U	10 U	10 U	10 U
Arsenic	Dissolved	50	0.045	--	--	--	1 UJ	1 U
	Total	50	0.045	1.8	1.6	1 U	1 U	1.3
Barium	Dissolved	2,000	2,600	--	--	--	203	213
	Total	2,000	2,600	211	204	197	187	276
Cadmium	Dissolved	5	18	--	--	--	0.2 U	0.2 U
	Total	5	18	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Chromium	Dissolved	100	110	--	--	--	3.4 J	2.1
	Total	100	110	3.1	1 U	1 U	1 U	1 U
Lead	Dissolved	15	NC	--	--	--	1 U	1 U
	Total	15	NC	1.7	1 UJ	1 U	1.5	1 U
Mercury	Total	2	11	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Selenium	Dissolved	50	180	--	--	--	2 UJ	2 U
	Total	50	180	2 U	2 U	2 U	2 U	2 UJ
Silver	Total	182.5	180	0.2 R	0.2 UJ	0.2 UJ	0.2 U	0.2 U

NC - USEPA Region 9 does not have a tap water PRG for lead.

-- The sample was not analyzed for dissolved metals

Shading indicates the exceedance of the IDEM Residential Default RISC criteria.

Qualifiers: U - not detected; J - estimated; R - rejected; UJ - not detected, estimated reporting limit

The results summarized are from groundwater sampling events performed by AGC following the RCRA Facility Work Plan.



TABLE 4-7
SUMMARY OF GROUNDWATER RESULTS
Well MW-5
Refined Metals Corporation
Beech Grove, Indiana

Parameter		IDEM Residential Default RISC Criteria (µg/L)	USEPA Region 9 Tap Water PRGs (µg/L)	Sampling Events					
				9/22/1999	12/14/1999	9/24/2001	12/11/2001	10/26/2003	4/24/2005
Antimony	Dissolved	6	15	—	—	—	10 U	10 U	1 U
	Total	6	15	10 U	10 U	10 U	10 U	10 U	1 U
Arsenic	Dissolved	50	0.045	—	—	—	3.7 J	2.4	1.2
	Total	50	0.045	8.4	10	7.6	5.4	8.8	3.2
Barium	Dissolved	2,000	2,600	—	—	—	170	154	179
	Total	2,000	2,600	149	162	170	150	159	177
Cadmium	Dissolved	5	18	—	—	—	0.2 U	0.2 U	0.2 U
	Total	5	18	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Chromium	Dissolved	100	110	—	—	—	4 J	2.2	1.2
	Total	100	110	1.5	1.9	1 U	1 U	1.1	1 U
Lead	Dissolved	15	NC	—	—	—	1 U	1 U	2.5
	Total	15	NC	1 U	1 UJ	2	2.1	2.1	9.1
Mercury	Dissolved	2	11	—	—	—	—	—	0.2 U
	Total	2	11	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	2 U
Selenium	Dissolved	50	180	—	—	—	2 UJ	2 U	2 U
	Total	50	180	2 U	2.9	2 U	2 U	2 UJ	0.2 U
Silver	Dissolved	182.5	180	—	—	—	—	—	0.2 UJ
	Total	182.5	180	0.2 R	0.2 UJ	0.2 UJ	0.2 U	0.2 U	0.2 UJ

NC - USEPA Region 9 does not have a tap water PRG for lead.

-- The sample was not analyzed for dissolved metals

Shading indicates the exceedance of the IDEM Residential Default RISC criteria.

Qualifiers: U - not detected; J - estimated; R - rejected; UJ - not detected, estimated reporting limit

The results summarized are from groundwater sampling events performed by AGC following the RCRA Facility Work Plan.



TABLE 4-8
SUMMARY OF GROUNDWATER RESULTS
Well MW-6S/6SR*
Refined Metals Corporation
Beech Grove, Indiana

Parameter		IDEM Residential Default RISC Criteria (µg/L)	USEPA Region 9 Tap Water PRGs (µg/L)	Sampling Events					
				9/23/1999	12/15/1999	9/24/2001	12/11/2001	10/26/2003	4/24/2005
Antimony	Dissolved	6	15	10 U	10 U	--	10 U	10 U	1 U
	Total	6	15	10 U	10 U	10 U	10 U	10 U	1 U
Arsenic	Dissolved	50	0.045	1.7	1.6	--	1.4 J	1.2	1.5
	Total	50	0.045	8.8 J	3.1	1.9	2.2	7.6	1 U
Barium	Dissolved	2000	2600	39	36	--	89	117	90
	Total	2000	2600	218	82	92	79	228	70
Cadmium	Dissolved	5	18	0.2 U	0.2 U	--	0.2 U	0.2 U	0.2 U
	Total	5	18	0.2	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Chromium	Dissolved	100	110	8.7	1 U	--	3.8 J	2.1	1.3
	Total	100	110	26	7.5	1 U	1 U	4.5	1 U
Lead	Dissolved	15	NC	1 U	1 UJ	--	1 U	1 U	1 U
	Total	15	NC	21	4.9 J	1 U	1.3	2.7	1 U
Mercury	Dissolved	2	11	0.2 U	0.2	--	--	--	0.2 U
	Total	2	11	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Selenium	Dissolved	50	180	2.9 J	2 U	--	2 UJ	2 U	2 U
	Total	50	180	4.9 J	2.1	2 U	2 U	2 UJ	2 U
Silver	Dissolved	182.5	180	0.2 U	0.2 UJ	--	--	--	0.2 UJ
	Total	182.5	180	0.2 UJ	0.2 UJ	0.2 UJ	0.2 U	0.2 U	0.2 UJ

* MW-6S reconstructed as MW-6SR between 12/15/1999 and 9/24/2001 sampling events

The results summarized are from groundwater sampling events performed by AGC following the RCRA Facility Work Plan.



TABLE 4-9
SUMMARY OF GROUNDWATER RESULTS
Well MW-6D
Refined Metals Corporation
Beech Grove, Indiana

Parameter		IDEM Residential Default RISC Criteria (µg/L)	USEPA Region 9 Tap Water PRGs (µg/L)	Sampling Events		
				9/21/1999	12/15/1999	4/24/2005
Antimony	Dissolved	6	15	—	—	1
	Total	6	15	10 U	10 U	1 U
Arsenic	Dissolved	50	0.045	—	—	3.2
	Total	50	0.045	24	31	3.2
Barium	Dissolved	2,000	2,600	—	—	60
	Total	2,000	2,600	293	301	64
Cadmium	Dissolved	5	18	—	—	0.2 U
	Total	5	18	0.2 U	0.2 U	0.2 U
Chromium	Dissolved	100	110	—	—	2.2
	Total	100	110	2	1 U	2.3
Lead	Dissolved	15	NC	—	—	1 U
	Total	15	NC	2.2	1.2 J	7.1
Mercury	Dissolved	2	11	—	—	0.2 U
	Total	2	11	0.2 U	0.2 U	0.2 U
Selenium	Dissolved	50	180	—	—	2 U
	Total	50	180	2.1	2 U	2 U
Silver	Dissolved	182.5	180	—	—	0.2 UJ
	Total	182.5	180	0.2 R	0.2 UJ	0.2 UJ

NC - USEPA Region 9 does not have a tap water PRG for lead.

— The sample was not analyzed for dissolved metals

Shading indicates the exceedance of the IDEM Residential Default RISC criteria.

Qualifiers: U - not detected; J - estimated; R - rejected; UJ - not detected, estimated reporting limit

The results summarized are from groundwater sampling events performed by AGC following the RCRA Facility Work Plan.



TABLE 4-10
SUMMARY OF GROUNDWATER RESULTS
Well MW-7
Refined Metals Corporation
Beech Grove, Indiana

Parameter		IDEM Residential Default RISC Criteria (µg/L)	USEPA Region 9 Tap Water PRGs (µg/L)	Sampling Events		
				9/22/2001	12/11/2001	10/27/2003
Antimony	Dissolved	6	15	–	10 U	10 U
	Total	6	15	10 U	10 U	10 U
Arsenic	Dissolved	50	0.045	–	30 J	25
	Total	50	0.045	25	26	290
Barium	Dissolved	2,000	2,600	–	23	15
	Total	2,000	2,600	21	25	17
Cadmium	Dissolved	5	18	–	0.2 U	0.2 U
	Total	5	18	0.2 U	0.2 U	0.2 U
Chromium	Dissolved	100	110	–	13 J	7.4
	Total	100	110	1 U	2.8	1.9
Lead	Dissolved	15	NC	–	2.5	1
	Total	15	NC	19	47	217
Mercury	Total	2	11	0.2 U	0.2 U	0.2 U
Selenium	Dissolved	50	180	–	6.5 J	2 U
	Total	50	180	3.7 J	5.7	2 UJ
Silver	Total	182.5	180	0.2 UJ	0.2 U	0.2 U

NC - USEPA Region 9 does not have a tap water PRG for lead.

– The sample was not analyzed for dissolved metals

Shading indicates the exceedance of the IDEM Residential Default RISC criteria.

Qualifiers: U - not detected; J - estimated; R - rejected; UJ - not detected, estimated reporting limit

The results summarized are from groundwater sampling events performed by AGC following the RCRA Facility Work Plan.



TABLE 4-11
SUMMARY OF GROUNDWATER RESULTS
Well MW-8
Refined Metals Corporation
Beech Grove, Indiana

Parameter		IDEM Residential Default RISC Criteria (µg/L)	USEPA Region 9 Tap Water PRGs	Sampling Events		
				9/22/2001	12/11/2001	10/28/2003
Antimony	Dissolved	6	15	—	10 U	10 U
	Total	6	15	14	10 U	10 U
Arsenic	Dissolved	50	0.045	—	14 J	17
	Total	50	0.045	5.1	13	19
Barium	Dissolved	2,000	2,600	—	135	79
	Total	2,000	2,600	133	123	89
Cadmium	Dissolved	5	18	—	0.3	0.2 U
	Total	5	18	0.8	0.4	0.2 U
Chromium	Dissolved	100	110	—	3.8 J	2.9
	Total	100	110	1 U	1 U	1.1 U
Lead	Dissolved	15	NC	—	11	15
	Total	15	NC	21	23	55 J
Mercury	Total	2	11	0.2 U	0.2 U	0.2 U
Selenium	Dissolved	50	180	—	2 UJ	2 U
	Total	50	180	2 U	2 U	2 UJ
Silver	Total	182.5	180	0.2 UJ	0.2 U	0.2 U

NC - USEPA Region 9 does not have a tap water PRG for lead.

— The sample was not analyzed for dissolved metals

Shading indicates the exceedance of the IDEM Residential Default RISC criteria.

Qualifiers: U - not detected; J - estimated; R - rejected; UJ - not detected, estimated reporting limit

The results summarized are from groundwater sampling events performed by AGC following the RCRA Facility Work Plan.



TABLE 4-12
SUMMARY OF GROUNDWATER RESULTS
Well MW-9
Refined Metals Corporation
Beech Grove, Indiana

Parameter		IDEM Residential Default RISC Criteria (µg/L)	USEPA Region 9 Tap Water PRGs	Sampling Events			
				9/22/2001	12/10/2001	10/27/2003	4/24/2005
Antimony	Dissolved	6	15	--	10 U	10 U	1 U
	Total	6	15	10 U	10 U	10 U	1 U
Arsenic	Dissolved	50	0.045	--	3.7 J	2.7	1 U
	Total	50	0.045	7.7	4	4.2	2.1
Barium	Dissolved	2,000	2,600	--	68	41	36
	Total	2,000	2,600	137	68	43	39
Cadmium	Dissolved	5	18	--	0.2 U	0.2 U	0.2 U
	Total	5	18	0.2 U	0.2 U	0.2 U	0.2 U
Chromium	Dissolved	100	110	--	3.8 J	1.9	1 U
	Total	100	110	1 U	2.2	1 U	1 U
Lead	Dissolved	15	NC	--	1 U	1 U	1 U
	Total	15	NC	1.6	1 U	1	2.2
Mercury	Dissolved	2	11	--	--	--	0.2 U
	Total	2	11	0.2 U	0.2 U	0.2 U	0.2 U
Selenium	Dissolved	50	180	--	2 UJ	2 U	2 U
	Total	50	180	2 U	2 U	2 UJ	2 U
Silver	Dissolved	182.5	180	--	--	--	0.2 UJ
	Total	182.5	180	0.2 UJ	0.2 U	0.2 U	0.2 UJ

NC - USEPA Region 9 does not have a tap water PRG for lead.

-- The sample was not analyzed for dissolved metals

Shading indicates the exceedance of the IDEM Residential Default RISC criteria.

Qualifiers: U - not detected; J - estimated; R - rejected; UJ - not detected, estimated reporting limit

The results summarized are from groundwater sampling events performed by AGC following the RCRA Facility Work Plan.



TABLE 4-13
SUMMARY OF GROUNDWATER RESULTS
Well MW-10
Refined Metals Corporation
Beech Grove, Indiana

Parameter		IDEM Residential Default RISC Criteria (µg/L)	USEPA Region 9 Tap Water PRGs	Sampling Event 10/28/2003
Antimony	Dissolved	6	15	10 U
	Total	6	15	10 U
Arsenic	Dissolved	50	0.045	7.5
	Total	50	0.045	24
Barium	Dissolved	2,000	2,600	16
	Total	2,000	2,600	71
Cadmium	Dissolved	5	18	0.2 U
	Total	5	18	0.2 U
Chromium	Dissolved	100	110	5.2
	Total	100	110	1.6 U
Lead	Dissolved	15	NC	1 U
	Total	15	NC	1 U
Mercury	Total	2	11	0.2 U
Selenium	Dissolved	50	180	2.3
	Total	50	180	2 U
Silver	Total	182.5	180	0.2 U

NC - USEPA Region 9 does not have a tap water PRG for lead.

– The sample was not analyzed for dissolved metals

Shading indicates the exceedance of the IDEM Residential Default RISC criteria.

Qualifiers: U - not detected; J - estimated; R - rejected; UJ - not detected, estimated reporting limit

The results summarized are from groundwater sampling events performed by AGC following the RCRA Facility Work Plan.



TABLE 4-14
SUMMARY OF GROUNDWATER RESULTS
Well MW-11
Refined Metals Corporation
Beech Grove, Indiana

Parameter		IDEM Residential Default RISC Criteria (µg/L)	USEPA Region 9 Tap Water PRGs (µg/L)	Sampling Event 10/27/2003
Antimony	Dissolved	6	15	10 U
	Total	6	15	10 U
Arsenic	Dissolved	50	0.045	7.1
	Total	50	0.045	7.1
Barium	Dissolved	2,000	2,600	167
	Total	2,000	2,600	167
Cadmium	Dissolved	5	18	0.2 U
	Total	5	18	0.2 U
Chromium	Dissolved	100	110	1 U
	Total	100	110	1.1
Lead	Dissolved	15	NC	1 U
	Total	15	NC	1 U
Mercury	Total	2	11	0.2 U
Selenium	Dissolved	50	180	2 U
	Total	50	180	2 UJ
Silver	Total	182.5	180	0.2 U

NC - USEPA Region 9 does not have a tap water PRG for lead.

– The sample was not analyzed for dissolved metals

Shading indicates the exceedance of the IDEM Residential Default RISC criteria.

Qualifiers: U - not detected; J - estimated; R - rejected; UJ - not detected, estimated reporting limit

The results summarized are from groundwater sampling events performed by AGC following the RCRA Facility Work Plan.



TABLE 4-15
SUMMARY OF GROUNDWATER RESULTS
Well MW-12
Refined Metals Corporation
Beech Grove, Indiana

Parameter		IDEM Residential Default RISC Criteria (µg/L)	USEPA Region 9 Tap Water PRGs (µg/L)	Sampling Event 4/24/2005
Antimony	Dissolved	6	15	1 U
	Total	6	15	1 U
Arsenic	Dissolved	50	0.045	1 U
	Total	50	0.045	1 U
Barium	Dissolved	2,000	2,600	86
	Total	2,000	2,600	86
Cadmium	Dissolved	5	18	0.2 U
	Total	5	18	0.2 U
Chromium	Dissolved	100	110	1 U
	Total	100	110	1 U
Lead	Dissolved	15	NC	1 U
	Total	15	NC	1 U
Mercury	Dissolved	2	11	0.2 U
	Total	2	11	0.2 U
Selenium	Dissolved	50	180	2 U
	Total	50	180	2 U
Silver	Dissolved	182.5	180	0.2 UJ
	Total	182.5	180	0.2 UJ

NC - USEPA Region 9 does not have a tap water PRG for lead.

– The sample was not analyzed for dissolved metals

Shading indicates the exceedance of the IDEM Residential Default RISC criteria.

Qualifiers: U - not detected; J - estimated; R - rejected; UJ - not detected, estimated reporting limit

The results summarized are from groundwater sampling events performed by AGC following the RCRA Facility Work Plan.



TABLE 4-16
SEPTEMBER 1999 GROUNDWATER VOLATILE RESULTS
RMC Beech Grove.

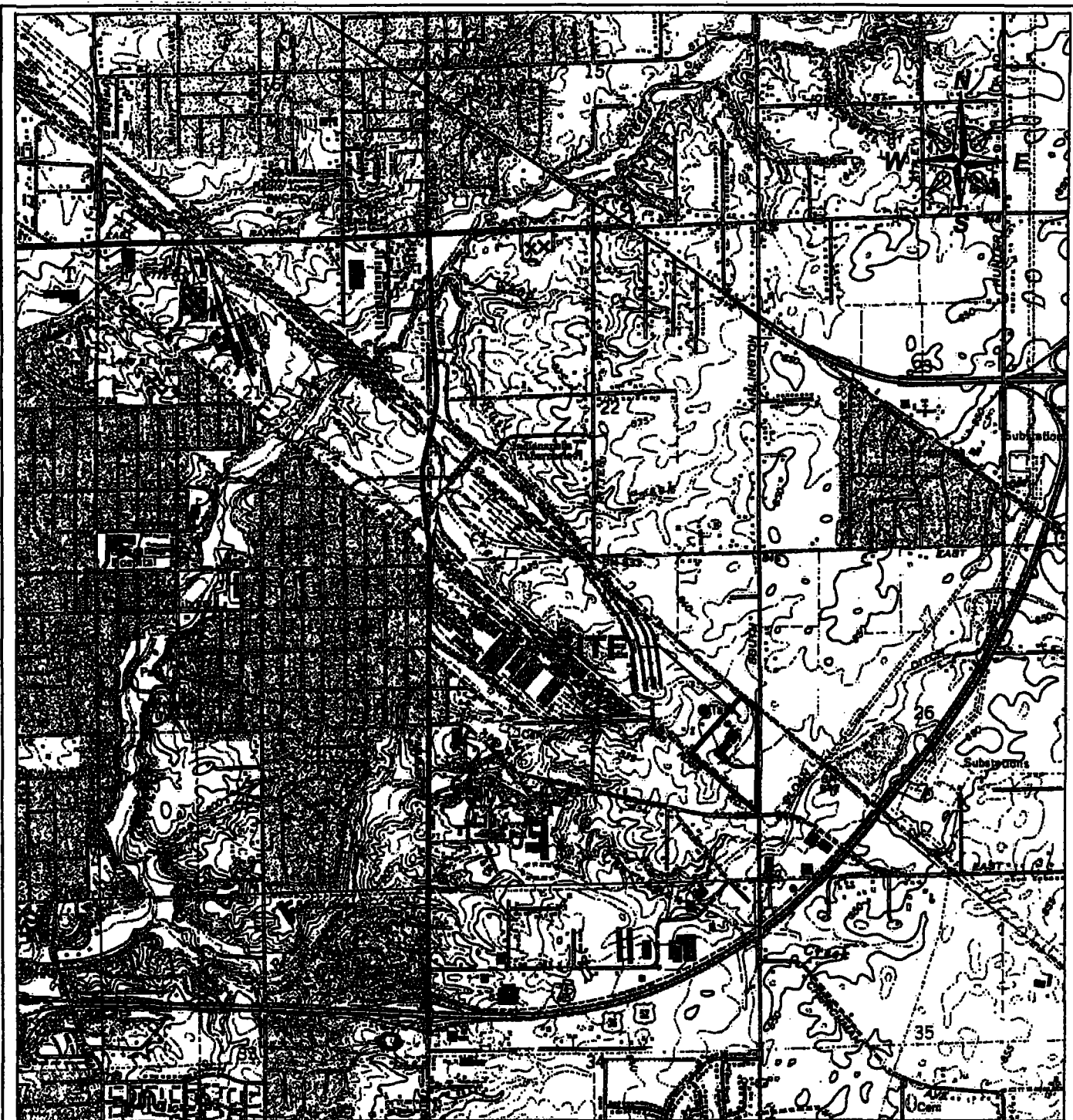
LOCATION		MW-1			MW-2S			MW-3			MW-4			MW-5			MW-6S		
LAB ID		232806			232802			232878			232879			232880			233021		
DATE COLLECTED		9/21/1999			9/21/1999			9/22/1999			9/22/1999			9/22/1999			9/23/1999		
MATRIX		Groundwater			Groundwater			Groundwater			Groundwater			Groundwater			Groundwater		
REMARKS																			
PARAMETER	UNITS	RESULT	Q	DL	RESULT	Q	DL	RESULT	Q	DL	RESULT	Q	DL	RESULT	Q	DL	RESULT	Q	DL
1,1,1-Trichloroethane	µg/L		U	1		U	1		U	1		U	1		U	1		U	1
Benzene	µg/L		U	1		U	1		U	1		U	1		U	1		U	1
Ethylbenzene	µg/L		U	1		U	1		U	1		U	1		U	1		U	1
Tetrachloroethene	µg/L		U	1		U	1		U	1		U	1		U	1		U	1
Toluene	µg/L		U	1		U	1		U	1		U	1		U	1		U	1





Refined Metals Corporation
Beech Grove, Indiana
Groundwater Monitoring Plan
Revised: January 26, 2006

FIGURES



REF. U.S.G.S. 7 1/2 MINUTE
BEECH GROVE, IND
QUADRANGLE MAP

REFINED METALS CORPORATION

BEECH GROVE, INDIANA

2000 0 2000 4000
SCALE IN FEET

Scale:
1"=2000'
Originated By:
K.M.S.
Drawn By:
P.S.G.
Checked By:
S.W.K.
Project Mgr:
P.G.S.
Dwg No.
2003-1046-05-02

SITE LOCATION MAP

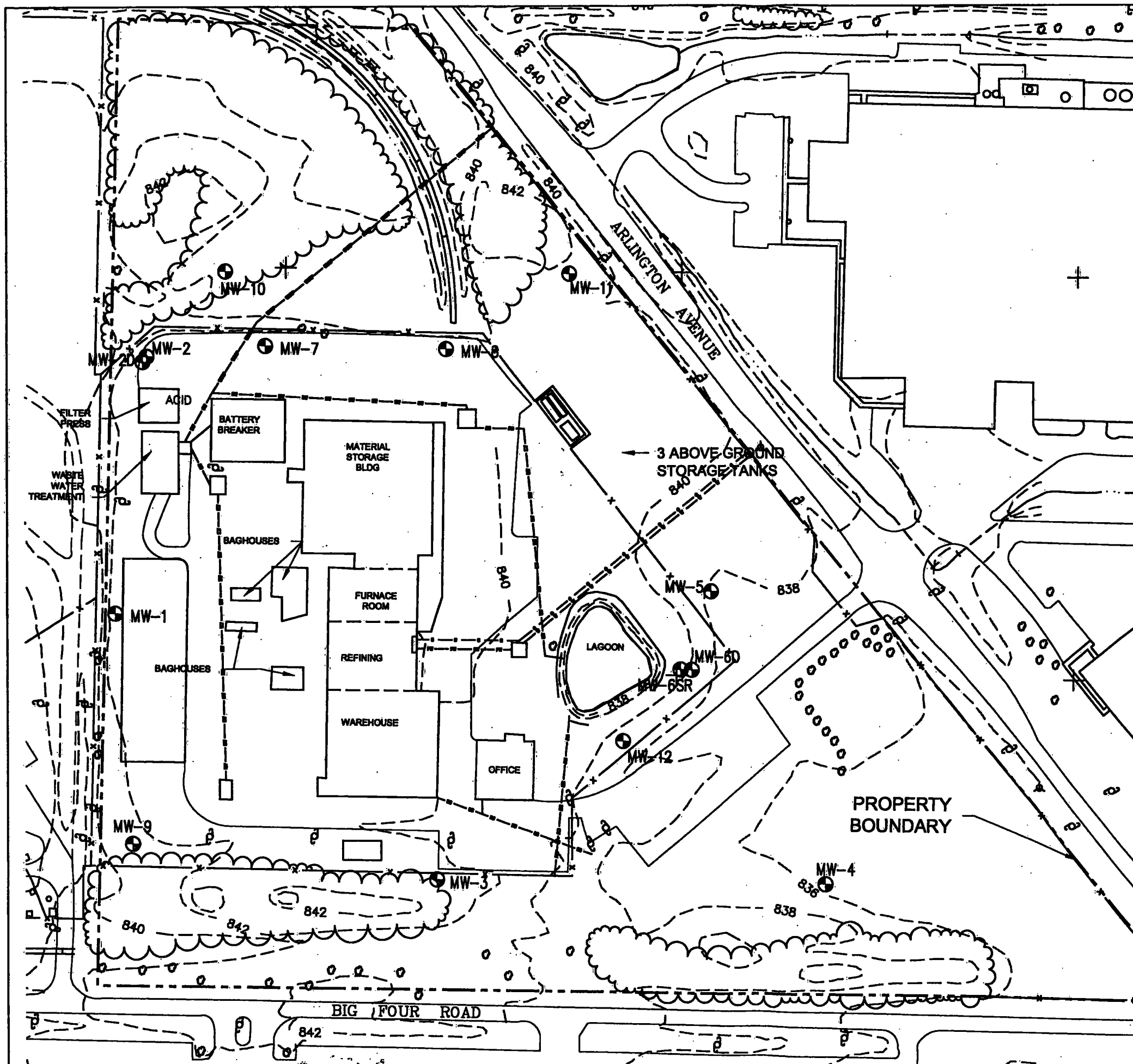


Advanced GeoServices Corp.
1055 Andrew Drive, Suite A
West Chester, Pennsylvania 19380
(810) 840-9100
FAX: (810) 840-9199

FIG 0 6 2003

2003-1046-05

FIGURE: 2-1



LEGEND

 MONITORING WELL LOCATION



REFINED METALS CORPORATION
 BEECH GROVE, IN

Scale:
 1"=130'
 Originated By:
 P.G.S.
 Drawn By:
 P.S.G.
 Checked By:
 P.G.S.
 Project Mgr:
 P.G.S.
 Dwg No.
 2003-1046-05-07
 Issued
 JAN 20 2004

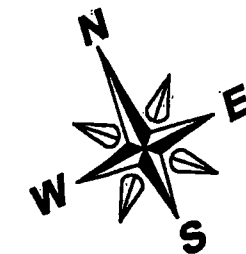
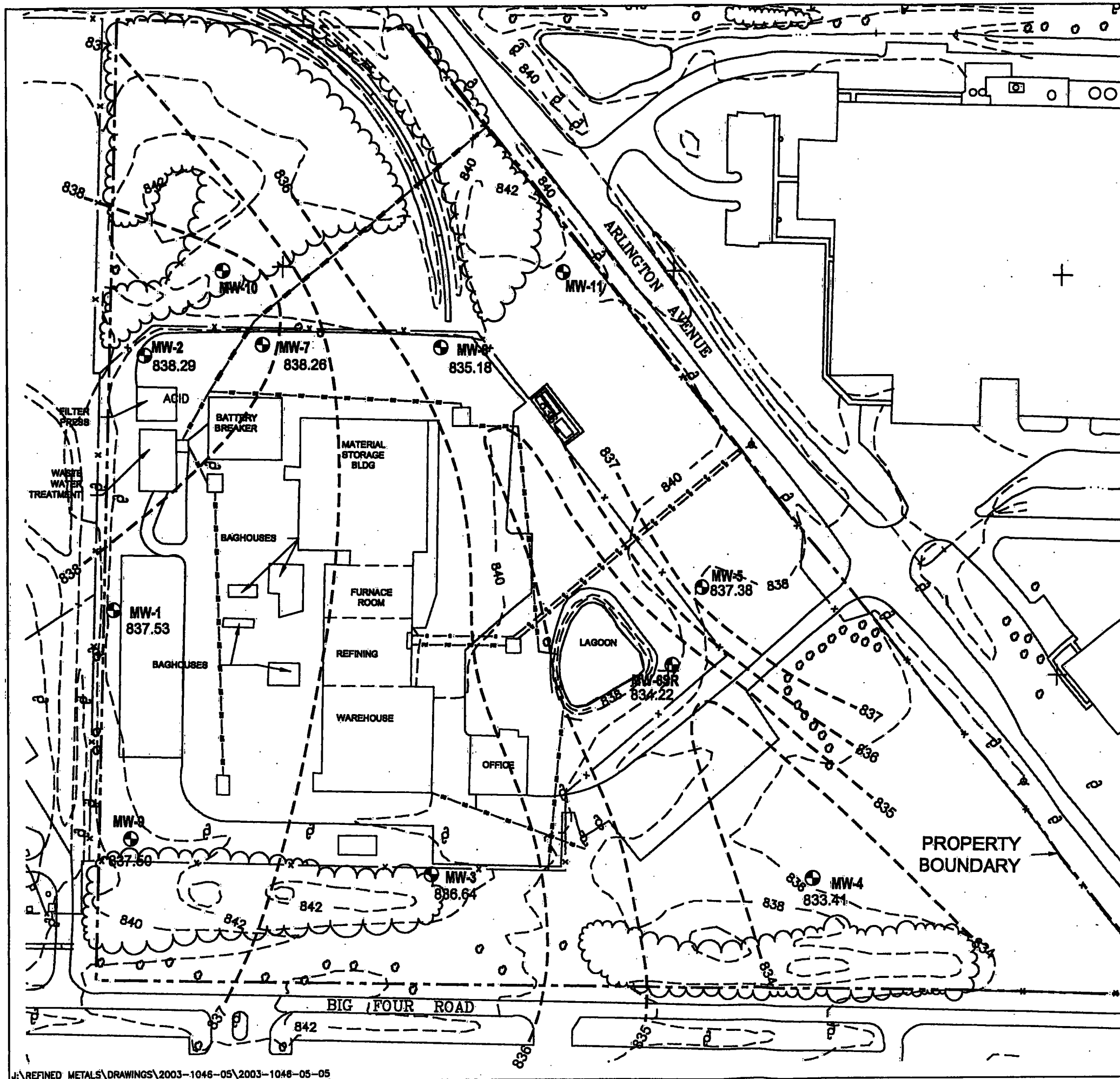
SITE PLAN



Advanced GeoServices Corp.
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 FAX: (610) 840-9199

2003-1046-05

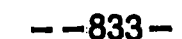
FIGURE: 2-2



LEGEND



SHALLOW MONITORING WELL



POTENTIOMETRIC SURFACE



REFINED METALS CORPORATION
BEECH GROVE, INDIANA

SITE MONITORING WELL LOCATIONS AND
SHALLOW GROUNDWATER POTENTIOMETRIC
MAP SEPTEMBER 2001

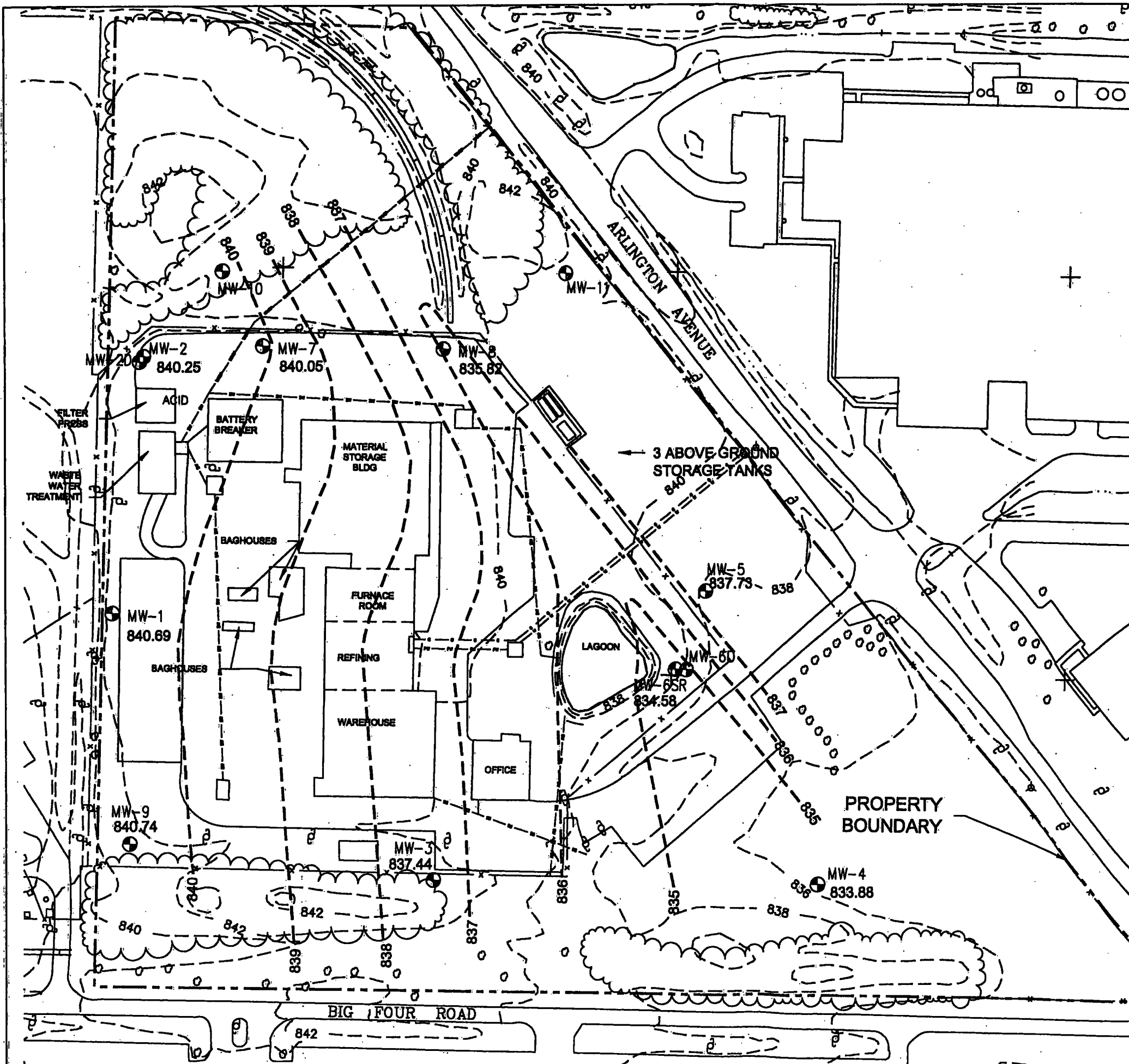


Advanced GeoServices Corp.
1055 Andrew Drive Suite A
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(610) 840-9100
FAX: (610) 840-9199

Scale:
1"=130'
Originated By:
J.S.W.
Drawn By:
S.M.F.
Checked By:
J.S.W.
Project Mgr:
P.G.S.
Dwg No.
2003-1048-05-01
Issued:
AUG 06 2003

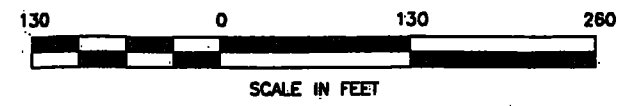
Project No.
2003-1048-05

FIGURE: 3-1



LEGEND

- MONITORING WELL LOCATION
- 833--- POTENTIOMETRIC SURFACE



REFINED METALS CORPORATION
BEECH GROVE, INDIANA

**SITE MONITORING WELL LOCATIONS
POTENTIOMETRIC MAP
DECEMBER 2001**

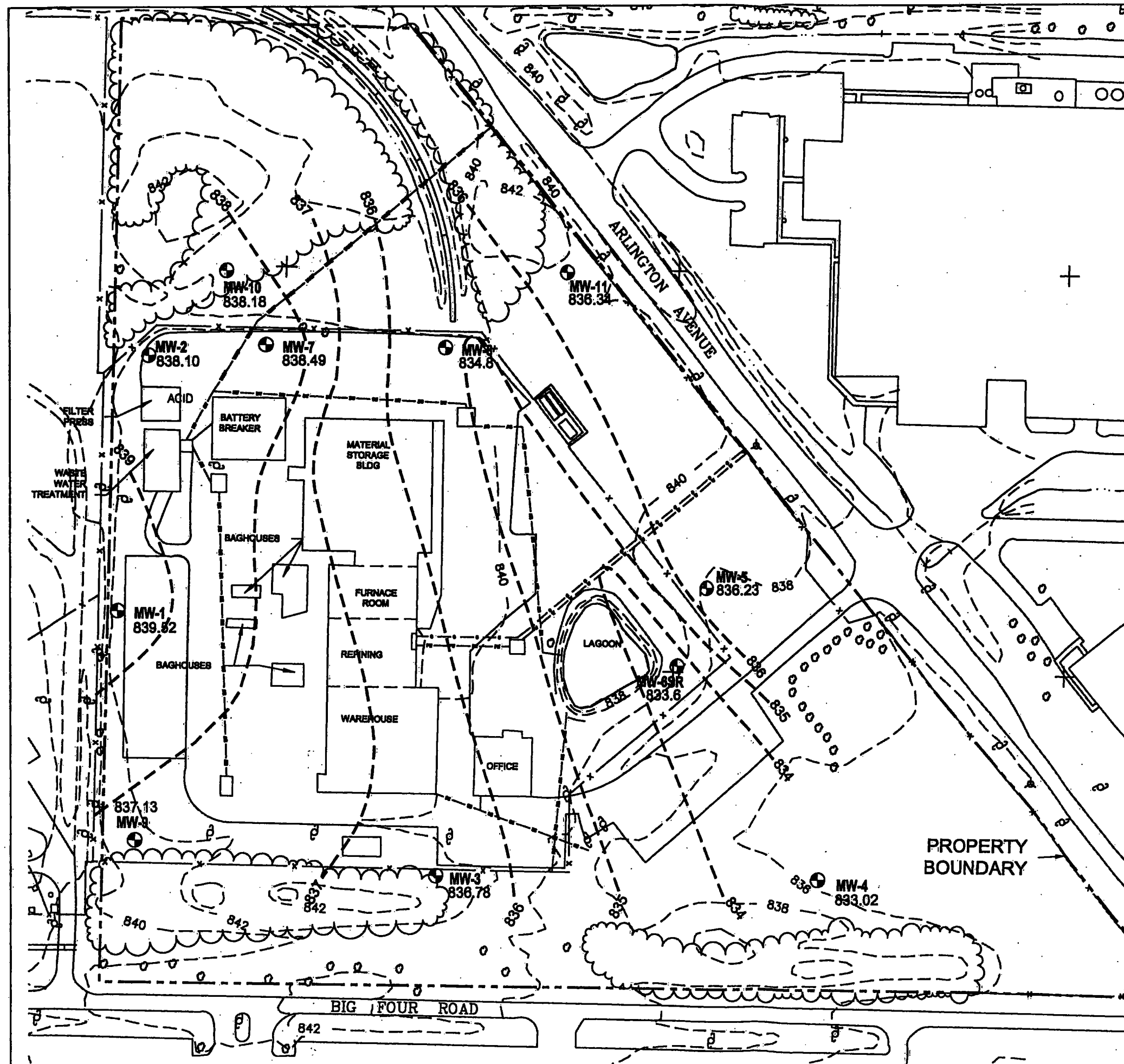


Advanced GeoServices Corp.
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West Chester, Pennsylvania 19380
(610) 840-9100
FAX: (610) 840-9199

Scale: 1"=130'
Originated By: P.G.S.
Drawn By: P.S.G.
Checked By: P.G.S.
Project Mgr: P.G.S.
Dwg No: 2003-1048-05-01
Iss: 06/2004

Project No: 2003-1048-05

FIGURE: 3-2



LEGEND

● SHALLOW MONITORING WELL—SURVEYED BY THE SCHNEIDER CORP., INDIANAPOLIS, IN

--833-- POTENTIOMETRIC SURFACE



REFINED METALS CORPORATION BEECH GROVE, INDIANA

SITE MONITORING WELL LOCATIONS AND
SHALLOW GROUNDWATER POTENTIOMETRIC
MAP OCTOBER 2003



Advanced GeoServices Corp.
1055 Andrew Drive Suite A
West Chester, Pennsylvania 19380
(610) 840-9100
FAX: (610) 840-9199

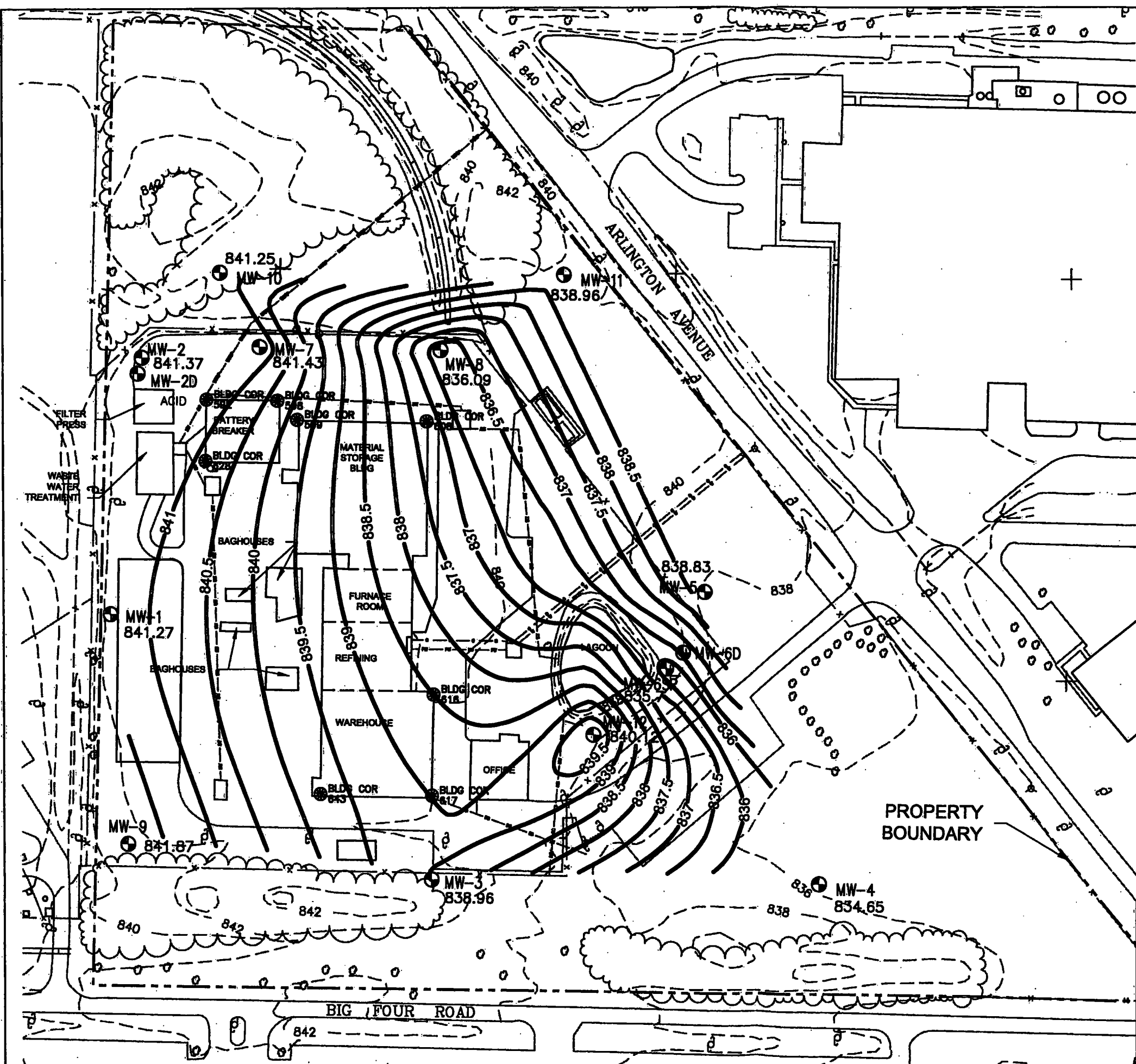
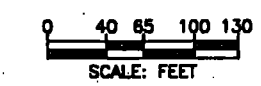
Scale:
1"=130'
Originated By:
K.M.S.
Drawn By:
P.S.G.
Checked By:
P.G.S.
Project Mgr:
P.G.S.
Dwg No.
2003-1046-05-0
Issued:
2003-1046-05

FIGURE: 3-3



LEGEND

● MONITORING WELL LOCATION



REFINED METALS CORPORATION
BEECH GROVE, INDIANA

**SITE MAP WITH APRIL 23, 2005
GROUNDWATER POTENTIOMETRIC MAP**



Advanced GeoServices Corp.
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West Chester, Pennsylvania 19380
(610) 840-9100
FAX: (610) 840-9199

Scale:	1"=130'
Originated By:	E.T.J.
Drawn By:	S.M.F.
Checked By:	P.G.S.
Project Mgr:	P.G.S.
Dwg No.	2003-1046-05-08

Project No. 2003-1046-05

FIGURE: 3-4



Refined Metals Corporation
Beech Grove, Indiana
Groundwater Monitoring Plan
Revised: January 26, 2006

APPENDIX A

Boring Logs

FULLER, HOSCHAGER, SCOTT AND MAY
CIVIL ENGINEERS, INC.
LEXINGTON, LOUISVILLE, KENTUCKY

SUBSURFACE LOG

Page 1 of 1

SITE NAME: Marion, Indiana
 PROJECT NUMBER: 90126
 FACE ELEVATION: N/A
 LOCATION: Hole #1
 DATE: 10/11/90
 LOGGED BY: Don Arnsperg
 COMPLETED: 10/11/90
 SITE TYPE: Monitoring Well Installation
 DEPTH TO WATER: 6.0'
 DATE AFTER COMPLETION: ---
 HOLE NUMBER: 1 TOTAL DEPTH: 30.0'

LITHOLOGY		DESCRIPTION	OVERBURDEN	SAMP. NO.	DEPTH	KIC. FT.	BLOWS	TYPE	REMARKS
ST.	DEPTH								
	5.0	Fill: intermixed clay, sandy clay, and construction debris (Excavated with backhoe)							
	21.0	Silty clay, brown, moist, medium stiff; with some sand and gravel		1	10.0-11.5	1.5	3/2/3	SPT	
				2	13.0-14.5	1.0	3/7/14	SPT	
				3	20.0-21.5	1.0	8/16/23	SPT	
	30.0	Sand, brown, fine to medium grained, medium dense		4	28.5-30.0	0.0	50+	SPT	
		Bottom of Hole - 30.0'							

FULLER, HOSSBAUGH, SCOTT AND MAY
CIVIL ENGINEERS, INC.
LEXINGTON, LOUISVILLE, KENTUCKY

SUBSURFACE LOG

Page 1 of 1

PROJECT: Marion, Indiana
 PROJECT NAME: Refined Metals Corporation
 SURFACE ELEVATION: N/A
 CLIENT: Craig Avery/David Mullins
 PROJECT TYPE: Monitoring Well Installation
 WELL NUMBER: 2 TOTAL DEPTH: 30.0'

PROJECT NUMBER: 90216
 LOCATION: Hole #2
 DATE STARTED: 10/10/90
 LOGGED BY: Don Albrecht
 DEPTH TO WATER: IMMEDIATE: 9.7' (0730 hrs.; 10/11/90)
 DEPTH TO WATER: DATE AFTER COMPLETION: 6.3' (1315 hrs.; 10/11/90)

COMPLETED: 10/11/90

LITHOLOGY		DESCRIPTION	OVERBURDEN	SAMP. NO.	DEPTH	SUC. FT.	SLOWS	TYPE	REMARKS
LEV.	DEPTH								
	0.0	Silty clay, brown, moist, medium stiff, with some sand and gravel		1	5.0-6.5	1.5	4/3/3	SPT	
				2	10.0-11.5	1.5	4/6/6	SPT	
				3	15.0-16.5	1.0	5/10/15	SPT	
	20.0	Clayey sand and silt, brown, wet, medium dense		4	20.0-21.5	0.0	3/3/15	SPT	
				5	25.0-26.5	1.0	5/12/20	SPT	
	28.0			6	28.5-30.0	1.5	10/22/31	SPT	
	30.0	Clay, gray, moist, stiff, with occasional gravel							
		Bottom of Hole - 30.0'							

SUBSURFACE LOG

CITY: Marion, Indiana
 WORK TYPE: Refined Metals Corporation
 SPACE ELEVATION: N/A
 CLIENT: Craig Avery/David Mallins
 WORK TYPE: Monitoring Well Installation
 # NUMBER: 1 TOTAL DEPTH: 11.3'

PROJECT NUMBER: 90226
LOCATION: Hole 13
DATE SAMPLED: 10/17/90 COMPLETED: 10/17/90
LOGGED BY: Don Arnold
DEPTH TO WATER: IMMEDIATE
DEPTH TO MUD: DATE AFTER COMPL

Silty clay, brown, moist, medium stiff;
with some sand and gravel

ENTRANCE LOG

NAME: Markon, Indiana
 NAME: Refined Metals Corporation
 NAME: N/A
 NAME: Craig Avery/David Mullins
 NAME: Monitoring Well Installation
 NAME: 4 TOTAL DEPTH: 26.0'

PROJECT NUMBER: 39226
LOCATION: Hole #4
DATE STARTED: 10/15/50
LOGGED BY: Don Adams
DEPTH TO WATER: TIMEBASE: _____
DEPTH TO WATER: DAYS AFTER COMPL: _____

LITHOLOGY		DESCRIPTION	OVERBURDEN	SAMP. NO.	DEPTH	REC. PT.	BLOWS	TYPE	REMARKS
LEV.	DEPTH								
		Silty clay, brown, moist, medium stiff; with some sand and gravel.		1	5.0-6.5	1.5	2/1/2	SPT	
			2	10.0-11.5	1.0	3/9/11	SPT		
	15.0		3	15.0-16.5	1.0	12/17/13	SPT		
		Clayey sand and silt, brown, wet, medium dense		4	20.0-21.5	1.0	16/36/43	SPT	
	22.0								
		Clay, gray, moist, very stiff with occasional gravel		5	24.8-26.0	1.5	9/22/10	SPT	
	26.0								
		Bottom of Hole - 26.0'							

FULLER, HOSCHAGER, SCOTT AND MAX
CIVIL ENGINEERS, INC.
LEXINGTON, LOUISVILLE, KENTUCKY

SUBSURFACE LOG

Page 1 of 1

NAME: Marion, Indiana
 OWNER: Refined Metals Corporation
 CLIENT: Craig Avery/David Mallin
 PROJECT TYPE: Monitoring Well Installation
 WELL NUMBER: 5 TOTAL DEPTH: 25.0'
 PROJECT NUMBER: 90226
 LOCATION: Hole #5
 DATE STARTED: 10/12/90
 LOGGED BY: Don Amscott
 DEPTH TO WATER: IMMEDIATE
 DEPTH TO WATER: DATE AFTER COMPLETION: 10 (0900 hrs.) 10/12/90
 COMPLETED: 10/12/90

LITHOLOGY		DESCRIPTION	OVERBURDEN	SAMP. NO.	DEPTH	SEC. FT.	BLOW	TYPE	REMARKS
LEV.	DEPTH								
	1.0	Topsoil							
		Silty clay, brown; moist, medium stiff; with some sand and gravel		1	5.0-6.5	1.5	2/3/1	SPT	
				2	10.0-11.5	1.0	5/8/17	SPT	
	15.0			3	15.0-16.5	1.0	14/20/14	SPT	
		Clayey sand and silt, brown, wet, medium dense Gravel 16.0-17.0							
	25.0								
		Bottom of Hole - 25.0'							

BORING LOG

PAGE 1 OF 1

PROJECT NUMBER: 98-478-03		PROJECT NAME: RMC - Beech Grove				
BORING / WELL NUMBER: MW-6s		LOCATION: Beech Grove Indiana				
DIAMETER: 2"		WATER DEPTH: 16.0'			DATE/TIME: 8/12/99 1400	
GEOLOGIST: Eric Stanke		COMPLETION DEPTH: 17.0'			DATE STARTED: 8/12/99	
DRILLING METHOD: HSA		SAMPLING METHOD: Split Spoon			DATE COMPLETED: 8/12/99	
DRILLING SUBCONTRACTOR: Boert + Lane year		DEVELOPMENT METHOD: Large Shank Pump			YIELD: ~ 0.5 gpm	

DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 6 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
0.0'-1.0' SILT, tan with a trace of organics and subangular to angular gravel - dry (loose)		5 10 15 20 25 30	Data not collected.	Data not collected.	Not applicable.	Not applicable.	On 8/12/99 use 6" HSD and split spoons to determine where to set well. Well installed on 8/12/99
1.0'-5.0' SILT, tan with a trace of subangular to angular gravel - dry (5.0')							
5.0'-9.0' SILT, black with a trace of organics - moist (medium dense)							
9.0'-10.5' CLAY, light brown with a trace of silt and angular gravel - moist (medium dense) (10.5')							
10.5'-12.0' CLAY, brown with a trace of angular to subrounded gravel - wet (loose) (12.0')							
12.0'-16.0' CLAY, brown and dark brown mottled with a trace of fine sand, silt and angular gravel - moist (medium dense) (16.0')							
16.0'-16.5' SILT, light brown with angular to rounded gravel - wet (loose) (16.5')							
16.5'-21.0' CLAY, dark gray with a trace of fine sand and gravel - moist (medium dense) (21.0')							
21.0'-24.5' fine sandy SILT, gray - moist (loose)							
24.5'-31.0' medium SAND, gray with a trace of silt - moist (loose)							
Boring terminated at 31.0'							
Well screens from 7.0' to 17.0' bgs.							

BORING LOG

PAGE 1 OF 1

PROJECT NUMBER: 98-478-05	PROJECT NAME: RMC - Beech Grove	
BORING / WELL NUMBER: MW-65R	LOCATION: Beech Grove, Indiana	
DIAMETER: 4"	WATER DEPTH: 12.5'	DATE/TIME: 8/21/01
GEOLOGIST: Brendan O'Connell	COMPLETION DEPTH: 30.0'	DATE STARTED: 8/21/01
DRILLING METHOD: HSA	SAMPLING METHOD: HSA/SS	DATE COMPLETED: 8/21/01
DRILLING SUBCONTRACTOR: Board Langyear	DEVELOPMENT METHOD: Surged Block	YIELD: —

DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 6 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
0.0-5.0 Clay, brown-orange, dry with topsoil and sand, stiff			9.8 11.6 7.10 11.16	NA data not collected	NA		Well Construction
5.0-10.0 Clay, brown-gray, moist stiff		5	5.7 11.15 5.10 7.13				Riser: SCH. 40 PVC 0'-20'
10.0-15.0 Sandy Silt, brown-gray, stiff moist to saturated, (ML)		10	14.10 14.12				Screen: 0.0105 IRT SCH. 40 PVC 20'-30'
15.0-20.0 Sandy Silt, gray, stiff saturated, (ML)		15	14.12 15.15				Sand pack: #1 sand 18'-30'
20.0-25.0 sandy Silt, gray med. stiff saturated, ML		20	13.14 15.18 8.8 7.8 5.1 9.10				Bentonite: 16'-18' seal
25.0-30.5 Sandy Silt, gray, very stiff saturated, ML		25	14.10 10.10 16.16 2.27 10.5				Grout: 45% MPZC 10' hard 5% Bentonite 0'-16'
Boring terminated at 30.5'		30					Shelby tube collected at: 10'-12' 16'-18' For Sieve & Hydros Testing

BORING LOG

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PROJECT NUMBER: 98-498-0	PROJECT NAME: RMC - Beech Grove	
BORING / WELL NUMBER: MW-7	LOCATION: Beech Grove, Indiana	
DIAMETER: 4"	WATER DEPTH: 12.5'	DATE/TIME: 8/22/01
GEOLOGIST: Braden O'Donnell	COMPLETION DEPTH: 25'	DATE STARTED: 8/24/01
DRILLING METHOD: HSA	SAMPLING METHOD: HSA/SS	DATE COMPLETED: 8/23/01
DRILLING SUBCONTRACTOR: Beart Longyear	DEVELOPMENT METHOD: Surge & Block	YIELD: —

DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 8 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
0.0' - 5.0' Clay, gray to greenish gray moist to dry			1 4.9 12.2 14.10				Well Construction Riser: Sch. 40 PVC 0" - 15"
5.0' - 10.0' Clay, brown, dry to moist			19.11 7.11 14.13 8.11 12.11				Screen: Adaptor Sch. 40 PVC Sandpack: #1 Sand 15" - 25"
10.0' - 15.0' sandy silt, trace gravel brown to dark brown, stiff moist to saturated, ML			5.6 4.12 7.14 24.49				Remanite: 1F-15" Seal grout: 0" - 11"
15.0' - 20.0' sandy silt, light brown and gray, saturated, very stiff, ML			14.14 25.39 8.13 24.37 14.15				Shelly tube collected at 26" - 28" for sieve & hydro testing
20.0' - 25.0' sandy silt, light gray saturated, very stiff ML			12.12 15.10 4.18 16.24 24.49				
25.0' - 28.0' sandy silt, light gray saturated, very stiff - Hard (ML)			15.16 14.25 4.14 24.68				
Boring terminated at 28"							

BORING LOG

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PROJECT NUMBER: 98-478-05	PROJECT NAME: RAC-Beech Grove	
BORING / WELL NUMBER: MW-8	LOCATION: Beech Grove, Indiana	
DIAMETER: 4"	WATER DEPTH: 10.5'	DATE/TIME: 8/23/01
GEOLOGIST: Brendan O'Donnell	COMPLETION DEPTH: 30.0'	DATE STARTED: 8/24/01
DRILLING METHOD: HSA	SAMPLING METHOD: HSA/SS	DATE COMPLETED: 8/24/01
DRILLING SUBCONTRACTOR: Boart Longyear	DEVELOPMENT METHOD: Surged Block	YIELD: —

DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 6 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
0.0'-5.0' Clay with construction debris (FIR) brown to dark brown, moist, FL			1 12.6 14.1		NA		Well construction Riser: 54.40 ft 0'-20'
5.0'-10.0' same as above, FL			5 5.6 9.6 2.3 3.4				Screen: 0.0105 slot 56.540 ft 20'-30'
10.0'-15.0' sandy silt, gray, medium stiff, moist, ML			10 3.4 5.4 5.7 7.11 14.13				Sand: #1 Sand 0'-18'
15.0'-20.0' sandy silt, gray, M. stiff, saturated, ML			15 5.6 8.9 6.8 9.18 6.7				Grout: 0'-16' 4572/590 7.10 ft Portland Cement/Redmud
20.0'-25.0' sandy silt, gray, M. stiff, saturated, ML			20 1.13 6.7 7.18 7.11 19.5				
25.0'-30.0' sandy silt, gray, stiff, saturated, ML			25 14.3 16.4 4.7 14.23 9.44				
Boring terminated at 30'			30 3.15				

BORING LOG

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PROJECT NUMBER: 18-478-05	PROJECT NAME: RMC Beech Grove					
BORING / WELL NUMBER: MW-9	LOCATION: Beech Grove, Indiana					
DIAMETER: 4"	WATER DEPTH: 15.3'			DATE/TIME: 8/23/01		
GEOLOGIST: Brendan O'Donnell	COMPLETION DEPTH: 25'			DATE STARTED: 8/22/01		
DRILLING METHOD: HSA	SAMPLING METHOD: HSA/SS			DATE COMPLETED: 8/23/01		
DRILLING SUBCONTRACTOR: Bact Longyear	DEVELOPMENT METHOD: Surfactant			YIELD: —		

DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 6 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS			
0.0' - 5.0' Sand with construction debris, dry, FL		5	15/12 10/10 7/7 7/7 8/8 10/10 4/5 5/11 5/7 6/8 5/5 5/8 7/8 4/11 4/6 2/7 3/4 4/11 14/13 13/27 14/49 5/63 22/29 33/41 12/12	data not recorded	NA	NA	Well Construction			
5.0' - 10.0' same as above, FL		10	13-15'							
10.0' - 15.0' sandy silt, light gray, medium stiff, ML		15	15-15'							
15.0' - 20.0' sandy silt, light gray, stiff, ML		20	15-15'							
20.0' - 26.0' sandy silt, light gray, Hard, saturated (ML)		25	15-15'							
Boring terminated at 26'										Riser: sch. 40 PVC 0'-15' Screen: 0.0105/01 sch. 40 PVC 15'-22.5' Sand: #1 Sand PVC 13'-15' Bentonite: 11'-13' Seal Grout: 0'-11' Shelby tube completed at 22'-24" and 24'-26" for sieve and Hydro testing

BORING LOG

PAGE 1 OF 4

PROJECT NUMBER: 98-478-03		PROJECT NAME: RmL - Beech Grove	
BORING / WELL NUMBER: mw-10		LOCATION: Beech Grove Indiana	
DIAMETER: No well installed		WATER DEPTH: none encountered	
GEOLOGIST: Eric Stanku		COMPLETION DEPTH: 129.5'	
DRILLING METHOD: HSA and Roto-Sonic		SAMPLING METHOD: HSA & Roto-Sonic	
DRILLING SUBCONTRACTOR: Benit Longyear		DEVELOPMENT METHOD: Not Applicable	
		YIELD: Not Applicable	

DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 8 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
0.0'-3.0' CLAY, brown with construction debris - dry (fill) (loose) (3.0')							On 8/23/99 use Roto-Sonic rig to determine what depth to overdrive with 10' Augers and set 8" surface casing set 8" surface casing to 29.5' and grout. Logging in on 8/25/99.
3.0'-9.0' CLAY, brown - moist (loose) (9.0')							
9.0'-15.0' Clayey SILT, brown to dark brown - moist (loose) (15.0')							
15.0'-20.0' Fine sandy CLAY, light brown and gray with a trace of gravel moist (loose) (20.0')							
20.0'-23.0' SILT, dark and orange brown with a trace of subrounded to subangular gravel - moist (loose) (23.0')							
23.0'-26.0' Fine sandy SILT, light to dark gray with a trace of subangular to subrounded gravel dry (medium dense) (26.0')							
26.0'-28.0' Fine SAND, gray with a trace of silt and subangular to subrounded gravel dry (medium to medium dense) (28.0')							
28.0'-32.0' SILT, dark gray with a trace of subangular to subrounded gravel dry (medium to very dense) (32.0')							

Data not collected
 Data not collected
 Not applicable
 Not applicable

Surface Casing Set to 29.5'
 Begin 8" Roto-Sonic
 drilling and 6" casing
 used sampling from 29.5'
 to 77.0' on 8/30/99.

BORING LOG

MW-10


PAGE 2 OF 4

DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 6 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
32.0'-37.0' silty CLAY, dark gray with some subangular to subrounded gravel - dry (medium dense)		35					
(37.0')							
37.0'-40.0' Fine SAND, gray with a trace of silt and gravel - dry (medium dense)		40					
(40.0')							
40.0'-48.0' SILT, dark gray with a trace of gravel - dry (very dense)		45					
(48.0')							
48.0'-60.0' CLAY, dark gray and dark brown with a trace of coarse sand - moist (medium to very dense)		50					
(60.0')							
60.0'-62.0' Fine SAND, gray with a trace of silt - moist (Loose)		60					
(62.0')							
62.0'-66.0' SILT, dark gray with 4" fine sand lenses - moist (very dense)		65					
(66.0')							
66.0'-68.0' Fine SAND, dark gray with a trace of silt and gravel - moist (Loose)							
(68.0')							
68.0'-70.0' SILT, dark gray with some subangular to subrounded gravel - dry (medium to very dense)		70					
(70.0')							

BORING LOG

MW-10

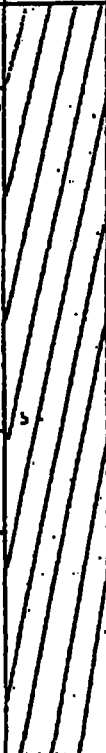

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DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 6 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
70.0' - 77.0' SILT, dark gray with a trace of subrounded to subangular gravel - moist (medium to very dense)		75					Continuous Auto-Log sampling and drilling from 72.0' to 124.5' on 8/31/99.
(77.0')		80					
77.0' - 93.0' SILT, dark gray with a trace of gravel and intermittent clay and fine sand lenses - moist (medium to very dense)		85					
(93.0')		90					
93.0' - 98.0' silty CLAY, dark gray with a trace of subrounded to subangular gravel - dry (very dense)		95					
(98.0')		100					
98.0' - 102.0' CLAY, glauconitic with brown sandy clay lenses - moist (loose)		105					
(102.0')							
102.0' - 110.0' CLAY, light brown with a trace of silt and gravel - dry (medium to very dense)							

BORING LOG

N.W. - 10

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DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 8 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
(110.0') 110.0-120.0' SILT, gray to dark gray with a trace of gravel - dry (very dense)		110					
(120.0') 120.0'-123.0' CLAY, dark gray with a trace of fine sand and gravel - dry (medium dense)		115					
(123.0') 123.0'-129.5' Fine to coarse sandy CLAY, dark gray with a trace of gravel - moist (medium dense)		120					
(129.5') Boring terminated at 129.5'		125					
		130					As work plan cease Auto-sonic sampling and drilling at 1300 on 8/21/99 at 1540hr Recovered sample to 125 Boring is dry. Boring sealed/filled to surface with a 95% cement/ 5% bentonite grout on 8/21/99.
							 8" bore hole with 95/5% grout

BORING LOG

PAGE 1 OF 4

PROJECT NUMBER: 98-478-03		PROJECT NAME: R.M.C. Beach Grove				
BORING / WELL NUMBER: MW-20		LOCATION: Beach Grove Indiana				
DIAMETER: 4"		WATER DEPTH: 6' Water @ 21.75'			DATE/TIME: 8/12 @ 0920	
GEOLOGIST: Eric Stanku		COMPLETION DEPTH: Well E.O.P. 110.0'			DATE STARTED: 8/12/99	
DRILLING METHOD: HSA and Rate-Sonic		SAMPLING METHOD: HSA/112 Roto-Sonic			DATE COMPLETED: 8/21/99	
DRILLING SUBCONTRACTOR: Boar + Longyear		DEVELOPMENT METHOD: Sweep / Wash / Air Jet			YIELD: ~ 3 gpm	

DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 8 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
0.0-1.5' Asphalt (46") stone and rubble (4.5')							On 8/12/99 use 6 1/4" HSA and spl. L open sampling to determine what depth to overdrill with 10" augers and set 8" surface casing. Set 8" surface to 31.0' on 8/12/99. Grout casing in on 8/12/99.
1.5-4.0' CLAY, gray with a trace of organic and gravel - moist (loose)							
4.0-7.0' CLAY, black, gray and brown with some silt - moist (loose to med. dense)		5					
7.0-7.25' GRAVEL, limestone with some silt (loose) (7.25')							
7.25-12.0' CLAY, light brown and gray with some silt - moist (medium dense)		10					
12.0-15.5' CLAY, light brown with some silt and a trace of fine sand and subangular to subrounded gravel - moist (medium dense) (15.5')		15					
15.5-16.0' FINE SAND, coarse (16.0')							
16.0-21.75' S<, tan with some fine sand and a trace of coarse sand - moist (loose)		20					
21.75-22.0' FINE SAND, brown - moist (loose) (22.0')							
22.0-25.0' Grades from material at 21.75' to heavy fine SAND with silt - moist (loose)		25					
25.0-26.25' S<, dark brown with a trace of clay and subangular to subrounded gravel - moist (medium dense) (26.25')							
26.25-27.0' FINE SAND, light brown with some silt and a trace of gravel - moist (loose)							
27.0-31.0' S<, dark brown with a trace of clay and gravel - dry (very dense)		30					Surface casing set to 31.0' Begin 8" Roto-Sonic drilling and 6" Roto-Sonic for tie down.
31.0-49.0' S<, dark brown and dark gray with a trace of subangular to subrounded gravel -							

BORING LOG

MW-2A

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DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 6 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
dry (medium to very dense)		35					Sampling from 31.0' to 110.0' on 8/21/99.
		40					
		45					
(49.0')		50					
49.0'-50.0' Fine sandy CLAY, dark gray and black with a trace of gravel - moist (medium dense)							
50.0'-51.0' CLAY, dark gray with a trace of fine sand - moist (medium dense)							
(56.0')		55					
56.0'-58.0' CLAY, glauconitic with a trace of gray fine sand and silt - moist (medium dense)							
(58.0')							
58.0'-60.0' SILT, gray and tan mottled with some clay and a trace of fine sand and gravel - moist (medium to very dense)		60					
(60.0')							
60.0'-68.0' Fine sandy SILT with a trace of gravel - moist (loose to medium dense)		65					
(68.0')							
68.0'-70.0' Coarse SAND, black and gray with gravel and in some places very fine sand lenses - wet (very loose)		70					

BORING LOG

MW-20





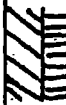
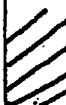

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DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 6 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
		75					
(80.0') 80.0-84.0' silty medium SAND, gray with a trace of gravel - moist (loose)		80					
(84.0') 84.0-90.5' very fine SAND, gray - moist (loose)		85					
(90.5') 90.5-96.0' SILT, dark gray with a trace of gravel - dry (medium to very dense)		90					
(96.0') 96.0-99.0' silty CLAY, brown and gray mottled - dry (medium dense)		95					
(99.0') 99.0-110.0' SILT, dark gray with a trace of gravel - dry (very dense)		100					
		105					

BORING LOG

MW-20

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DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 5 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
Boring terminated at 110.0'		110					<p>Per conversation w Project Geologist at Roto-Sonic company drilling at 110.0' on slurry. Build bore boring to 80.0' or begin well constr. at 80.0'.</p> <div>  8" borehole 15/16" groove and 1" diameter PVC casing  8" borehole bentonite 6" diameter PVC casing  8" borehole 25 sand and 4" diameter PVC casing  8" borehole 25 sand and 4" diameter PVC casing  8" borehole with vent  8" borehole with 25 sand </div>

BORING LOG

PAGE 1 OF 4

PROJECT NUMBER: 98-478-03		PROJECT NAME: RML - Beech Grove				
BORING / WELL NUMBER: MW-30		LOCATION: Beech Grove, Indiana				
DIAMETER: No well installed.		WATER DEPTH: 1st water table: 13.75'		DATE/TIME: 8/11/99		
GEOLOGIST: Eric Stacker		COMPLETION DEPTH: 130'		DATE STARTED: 8/11/99		
DRILLING METHOD: HSA and Koto-Sonic		SAMPLING METHOD: HSA/PS & Koto-Sonic		DATE COMPLETED: 8/21/99		
DRILLING SUBCONTRACTOR: Goert Longyear		DEVELOPMENT METHOD: Not Applicable		YIELD: Not Applicable		

DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 8 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
0.0'-1.0' SILT, tan with trace organics - dry (1.0')							On 8/11/99 use 6 1/4" HSA and split spoon sampling to determine what depth to overdrill with 10" augers and set 8" surface casing. Set 8" surface casing to 32' on 8/11/99. Grout casing in on 8/12/99.
1.0'-2.0' SILT, gray and brown mottled with trace rock fragments - dry (2.0')							
2.0'-6.0' SILT, brown and tan mottled with trace of subrounded to rounded gravel - dry (6.0')							
6.0'-8.5' Fine sandy CLAY, light brown and tan with a trace of subrounded gravel - dry (8.5')							
8.5'-10.25' silty fine SAND with trace of subrounded to rounded gravel - moist (10.25')							
10.25'-13.0' CLAY, brown with trace of fine to coarse sand - moist (13.0')							
13.0'-13.75' SILT, gray - dry (13.75')							
13.75'-14.0' SAND, gray medium to coarse with trace clay - wet (14.0')							
14.0'-19.5' CLAY, gray with some subangular to rounded gravel - moist and medium dense (19.5')							
19.5'-20.0' silty fine SAND, with trace of subrounded to rounded gravel - moist (20.0')							
20.0'-21.5' subangular to rounded gravelly SILT, gray and wet (21.5')							
21.5'-24.5' SILT, gray with some subrounded to rounded gravel - moist (24.5')							
24.5'-25.0' fine to coarse SAND - dry (25.0')							
25.0'-26.0' SILT, gray - dry (26.0')							
26.0'-26.5' clayey fine SAND, medium dense (26.5')							
26.5'-28.5' clayey SILT, gray with trace of rounded to sub rounded gravel - dry (medium dense) (28.5')							
28.5'-29.0' CLAY, brown with trace of fine sand (medium to very dense) - moist (29.0')							
29.0'-32.0' CLAY, gray with trace gravel and silt - dry (very dense) (32.0')							
32.0'-35.0' clayey SILT, gray with trace of							Surface casing set to 32.0' on 8/12/99.

BORING LOG

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DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 6 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
Subrounded gravel - dry (very dense) (35.0')		35					drilling and 6" Auto- sonic Continuous sam- pling From 32.0' to 55.0' on 8/18/99.
35.0'-37.0' SILT, gray with trace clay and subangular to subrounded gravel to 1" in diameter - moist (loose) (37.0')							
37.0'-42.0' SILT, gray with some subrounded to rounded gravel - dry (medium to very dense) (42.0')		40					
42.0'-45.0' SILT, gray - dry (very dense) (45.0')							Continuous Auto-sonic sampling and drilling from 55.0' to 117.0' on 8/19/99.
45.0'-48.0' medium SAND, gray and black - wet grades to medium to coarse SAND, gray and black with some gravel - wet (very loose) (48.0')		45					
48.0'-52.0' SILT, gray to black - dry (very dense) (52.0')		50					
52.0'-54.5' glauconitic CLAY, mixed with fine sand and gravel - dry (medium to very dense) (54.5')							
54.5'-59.0' CLAY, light brown with some fine sand and a trace of gravel - moist (loose to medium dense) (59.0')		55					
59.0'-60.0' SILT, gray interbedded with light brown sand (medium dense) (60.0')							
60.0'-62.0' SAND, light brown with a trace of silt and gravel - dry (medium dense) (62.0')		60					
62.0'-66.0' SILT, dark gray to gray with a trace clay and gravel - dry (medium dense) (66.0')		65					
66.0'-69.0' CLAY and fine SAND, light brown and gray - dry (medium dense) (69.0')							
69.0'-70.0' coarse SAND, gray and black with some gravel and a trace of silt (loose) (70.0')		70					

BORING LOG

AW-30


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DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 6 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
70.0'-77.0' SILT, gray with a trace of gravel - dry (medium to very dense)		75					
(77.0')							
77.0'-80.0' SILT, gray with some gravel - wet (loose)		80					
80.0'-81.0' gravelly SILT, gray to dark gray - wet (loose)							
(81.0')							
81.0'-85.0' SILT interbedded with SAND, both gray. Silt has some clay - dry (medium dense). Sand is medium to coarse with a trace of gravel (medium dense).		85					
(85.0')							
85.0'-90.0' SILT, gray with a trace of sub- angular to sub rounded gravel - dry (medium dense)		90					
(90.0')							
90.0'-90.5' fine to medium SAND, gray - wet (loose)		90					
(90.5')							
90.5'-98.0' silty CLAY, gray with a trace of sub angular to sub rounded gravel - dry (medium to very dense)		95					
(98.0')							
98.0'-105.0' CLAY, light brown and light gray mottled with a trace of silt and gravel - dry (medium to very dense)		100					
(105.0')							
105.0'-114.5' clayey SILT, light brown with a trace of gravel - dry (medium dense)		105					

BORING LOG

MW-30

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DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 6 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
<p>(114.5')</p> <p>114.5' - 127.0' fine sandy SILT, gray-dry (very dense) (tree branch at 115.0')</p> <p>(127.0')</p> <p>127.0' - 130.0' very fine SAND, gray-moist (medium to very dense)</p> <p>(130.0')</p> <p>Boring terminated at 130.0' per work plan.</p>		<p>110</p> <p>115</p> <p>120</p> <p>125</p> <p>130</p>					<p>Continuous Roto-Son sampling and drilling from 112.0' to 130.0' on 8/20/99.</p> <p>Per work plan close Roto-Sonic sample and drilling at 130' on 8/20/99 at 0910h. Boring is dry. Borehole sealed/filled to surf with a 95% cement-5% bentonite slurry on 8/20/99.</p> <p>8" borehole 9.5/5% gr.</p>

BORING LOG

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PROJECT NUMBER: 98-478-03		PROJECT NAME: RML - Beech Grove				
BORING / WELL NUMBER: MW-60		LOCATION: Beech Grove Indiana				
DIAMETER: 4"		WATER DEPTH: 26.0'			DATE/TIME: 8/12/99 c. 1100	
GEOLOGIST: Eric Stanke		COMPLETION DEPTH: 123.0'			DATE STARTED: 8/12/99	
DRILLING METHOD: HSA and Auto-Sonic		SAMPLING METHOD: HSA and Auto-Sonic			DATE COMPLETED: 8/18/99	
DRILLING SUBCONTRACTOR: Becht Longyear		DEVELOPMENT METHOD: Superblast pump			YIELD: ~ 2 gpm	

DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 8 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
0.0'-10.0' See MW-6s log.		5					On 8/12/99 use data from MW-6s to auger without sampling to 10.0' HSA/SS From 10.0' to 19.0' On 8/18/99 over drill hole with 10" pumps and set 8" casing to 19.0'
10.0'-14.0' CLAY, dark brown and tan mottled with some subrounded gravel and a trace of fine sand - moist (loose)		10					
14.0'-16.0' silty CLAY, dark brown and brown mottled with some subrounded gravel - moist (medium dense)		15					
16.0'-19.0' SILT, dark gray with a trace of sub-rounded gravel - moist (medium dense)		20					
19.0'-24.0' Fine SAND, gray with a trace of s.H. and angular gravel and intermittent c/s. Dark clay lenses - moist (loose)		25					
24.0'-26.0' silty CLAY, brown and gray mottled with a trace of fine sand and sub angular to sub rounded gravel - moist (medium dense)		30					Surface casing set to 4.0' Begin 8" Auto-Sonic drive and 6" Auto-Sonic continuous sampling from 19.0' to 105.0' on 8/17/99.
26.0'-28.0' Fine to coarse SAND, brown with a trace of silt & some gravel - moist (medium dense)							
28.0'-28.5' silty CLAY, gray with a trace of fine sand and sub rounded gravel - dry (medium dense)							
28.5'-29.0' Fine to coarse SAND - moist (loose)							
29.0'-30.0' silty CLAY, gray with a trace of fine sand - dry (medium dense)							
30.0'-44.0' CLAY, gray with some sub angular to sub rounded gravel - dry (medium to very dense)							

BORING LOG

mw-69

PAGE 2 OF 4

DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 8 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
		35					
		40					
		45					
(44.0')							
44.0'-46.0' clayey GRAVEL, gray subangular to rounded - wet (loose)							
(46.0')							
46.0'-47.0' CLAY, gray with some subangular to subrounded gravel - dry (medium to very dense)							
(47.0')							
47.0'-50.0' Fine SAND to Gravel, poorly sorted gray - wet (very loose)							
(50.0')		50					
50.0'-56.0' CLAY, glauconitic with a trace of rounded gravel - dry (very dense)							
		55					
(58.0')							
58.0'-60.0' Fine SAND, brown with some silt and a trace of gravel grades to Fine SAND, brown with a trace of silt and gravel - wet (Loose)							
(60.0')		60					
60.0'-62.0' Fine sandy SILT, light brown with a trace of subangular to subrounded gravel - dry (medium dense)							
(62.0')							
62.0'-72.0' SILT, light brown with a trace of clay, subrounded gravel and fine sand - dry (medium dense)							
		65					
		70					

BÖRING LÖG

ML-60

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DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 6 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
(72.0')							
72.0'-72.0' Fine SAND, light brown to dark gray with a trace of silt and gravel - moist (Loose)		75					
(82.0')		80					
82.0'-85.0' SILT, dark gray with some fine sand and gravel - moist (Loose)							
(85.0')		85					
85.0'-90.5' Fine SAND, dark brown to dark gray - moist (Loose)							
(90.5')		90					
90.5'-96.0' Fine to coarse SAND, dark gray with some gravel and a trace of silt - moist (Loose)							
(96.0')		95					
96.0'-99.0' Fine SAND, gray to dark gray with a trace of silt and gravel - moist (Loose)							
(99.0')		100					
99.0'-108.0' CLAY, gray with some gravel and a trace of silt - dry (medium to very dense)		105					

Continuous Rotation Sampling and Drilling
105.0' to 123.0' on 8/10/79

BORING LOG

mc-60

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DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 6 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
<p>(108.0')</p> <p>108.0'-123.0' silty CLAY, dark gray to gray with a trace of gravel <3" diameter - dry (medium to very dense)</p>		<p>110</p> <p>115</p> <p>120</p>					
<p>(123.0')</p> <p>Boring terminated at 123.0'</p>		<p>125</p> <p>130</p>					<p>Per conversation with Project Geologic Note Sources and drilling at 123 on 8/18/99, Build to 96.0' and begin re construction at 96.</p> <div>  <p>8" borehole 75/5% gravel and 4" diameter PVC casing.</p>  <p>8" borehole bentonite + 4" diameter PVC casing.</p>  <p>8" borehole 25 sand and 4" diameter PVC casing.</p>  <p>8" borehole 25 sand and 4" diameter PVC casing.</p>  <p>8" borehole with 45 sand.</p> </div>

LOG OF TEST BORING

TEST BORING MW-10

DATE: 9/9/03
 PROJECT: RMC Beech Grove
 BORING LOCATION: Beech Grove, Indiana
 DRILLING METHOD: 6-1/4" Hollow Stem Auger
 DRILLING COMPANY: Boart Longyear
 WATER ENCOUNTERED AT:

PROJECT NO.: 2003-1046
 SURFACE ELEVATION:
 CHECKED BY: PGS
 DRILLER: Dan
 INSPECTOR: S. Wiswall

ELEVATION / DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS BLOWS PER 6 INCHES	Soil Description	SPT (N)	Moisture (%)	Other Tests
0		0-5' Topsoil, some root mat.	0 0		
5	5/6 8/6 12/6 12/6	5-7' Stiff tan-brown to gray silty clay (CL) with frequent subangular to rounded fine gravel, dry to moist.	5.0 -5	24	
10	7/6 34/6 45/6 23/6	10-12' Medium stiff to stiff brown silty clay (CL), dry to moist.	16.0 -10	70	
15	15/6 17/6 43/6 46/6	12-15' Fine to coarse gravel with some clay, silt, poorly sorted subangular to rounded, saturated.	12.0 -12		
15	15/6 17/6 43/6 46/6	15-17' Very stiff brown silty clay, moist.	15.0 -15	89	
20	10/6 20/6 23/6 26/6	17-19' Hard gray silty clay with frequent fine gravel, subangular to rounded.	17.0 -17	51	
20	10/6 23/6 27/6 30/6	19-21' Very stiff to hard gray silty clay with fine gravel, moist.	19.0 -19	57	
25					
30					
35					
		END OF BORING	36.0 -36		

LOG OF TEST BORING

TEST BORING MW-11

DATE: 9/9/03
PROJECT: RMC Beech Grove
BORING LOCATION: Beech Grove, Indiana
DRILLING METHOD: 6-1/4" Hollow Stem Auger
DRILLING COMPANY: Boart Longyear
WATER ENCOUNTERED AT:

PROJECT NO.: 2003-1046
SURFACE ELEVATION:
CHECKED BY: PGS
DRILLER: Dan
INSPECTOR: S. Wiswall

ELEVATION / DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS BLOWS PER 6 INCHES	Soil Description	SPT (N)	Moisture (%)	Other Tests
0		0-5' Topsoil, leaves.	0 0		
5	8/6 19/6 42/6 36/6	5-7' Very stiff to hard tan-brown silty clay with occasional fine gravel, dry.	5.0 -5	78	
10	10/6 12/6 48/6 15/6	10-12' Very stiff tan-brown silty clay with occasional fine gravel, subangular to rounded, moist.	10.0 -10	63	
15	10/6 24/6 10/6 17/6 12/6 17/6 34/6 25/6	15-17' Stiff brown silty clay, moist.	15 -15	27	
		16-16.5' Medium dense, fine to coarse sand, poorly sorted, subangular to rounded upwardly fining, saturated.	16.0 -16 17.0 -17	59	
20	15/6 19/6 20/6 23/6	19-20' Very stiff to hard gray to brown silty clay, medium dense, fine silty sand, rounded upwardly, fining, saturated.	19.0 -19		
		21-23' Very stiff brown silty clay with occasional fine gravel, dry.	21.0 -21	43	
25		22.4-22.8' Medium dense gray fine to medium sand, well sorted, saturated.	22.4 -22.4 22.8 -22.8		
		22.8-23' Very stiff gray clay.			
30		END OF BORING	30 -30		
35					

LOG OF MONITORING WELL

MONITORING WELL NO. MW-12

PROJECT: Beech Grove, Indiana PROJECT NO.: 2003-1046
 LOCATION: Beech Grove, Indiana ELEVATION (TOIC): 845.15
 DRILLER: Dan/Nathan DRILLING METHOD: HSA DATE COMPLETED: 3/29/05
 WATER DEPTH: 6.5' LOGGED BY: Aaron Ulishney COMPLETION DEPTH: 27 feet

DEPTH	GRAPHIC LOG	WELL CONSTRUCTION DIAGRAM	DEPTH INTERVAL OF SAMPLE	USCS	DESCRIPTION	SAMPLER BLOWS/6"
0			0-2'		0-2' Clay, dark gray with orange tint with some organics, traces of iron, sticky, compacted, moist, toughness was high	3
			2-4'		2-4' Same as above	7
			4-6'		4-6' Clay, light gray-dark gray with well graded gravel, subrounded-rounded, max size >2mm, dry-moist	5
5			6-8'		6-8' Same as above	7
			8-10'		8-10' Silty clay, dark gray with smaller gravel >2mm, subrounded-rounded, toughness high, moist	9
			10-12'		10-12' Silty clay, light gray-dark gray with well graded gravels, subangular-subrounded, max size=1 inch, moist-wet with sand near 11.5 to 12.0 depth	12
			12-14'		12-14' Clay, light gray with gravels >2mm, well graded, subrounded-rounded, becoming wet	4
			14-16'		14-16' Clay, light gray with few well graded gravels and sands, max size >1 inch, subrounded-round, toughness high, moist-wet	5
15			16-18'		16-18' Same as above	5
			18-20'		18-19.5' Same as above	5
			20-22'		20-22' No soil sample in split spoon	8
			22-24'		21.6-22' Silty Sand, gray, loose, becoming saturated	4
			24-26'		22-23' Silty Clay, light gray with some sand and gravels, well graded, subrounded-round	7
25			26-27'		24-26' Silty Sand, light gray, poorly graded, saturated	13
					23-24.8' Sand, fine grained, light	14
						19
						9
						7
						8
						15
30						7

COVER TYPE:

Aboveground Well Protector

GROUT:

Type: Cement/Bentonite

Interval: 0-8'

FILTER PACK:

Interval: 10-27'

Case Type: PVC

SCREEN:

Interval: 12 to 27

Slot Size: 0.010"

BENTONITE SEAL:

Interval: 8'-10'

LOG OF MONITORING WELL

MONITORING WELL NO. MW-12

PROJECT: Beech Grove, Indiana

PROJECT NO.: 2003-1046

LOCATION: Beech Grove, Indiana

ELEVATION (TOIC): 845.15

DRILLER: Dan/Nathan

DRILLING METHOD: HSA

DATE COMPLETED: 3/29/05

WATER DEPTH: 6.5'

LOGGED BY: Aaron Ulishney

COMPLETION DEPTH: 27 feet

DEPTH	GRAPHIC LOG	WELL CONSTRUCTION DIAGRAM	DEPTH INTERVAL OF SAMPLE	USCS	DESCRIPTION	SAMPLER BLOWS/6"
35					gray, poorly graded, saturated	8
					24.8-26' Silty Clay, light gray,	7
					loose, saturated, few pebbles	9
					26-27' Sand, fine grained, light	5
					gray, poorly graded, saturated	5
					Terminated borehole at 27 ft	11
						19
						7
						7
						13
						22
						9
						9
						11
						15

COVER TYPE:

Aboveground Well Protector

GROUT:

Type: Cement/Bentonite

Interval: 0-8'

FILTER PACK:

Interval: 10-27'

Case Type: PVC

SCREEN:

Interval: 12 to 27

Slot Size: 0.010"

BENTONITE SEAL:

Interval: 8'-10'



Refined Metals Corporation
Beech Grove, Indiana
Groundwater Monitoring Plan
Revised: January 26, 2006

APPENDIX B

Quality Assurance Project Plan



APPENDIX B

**QUALITY ASSURANCE PROJECT PLAN
FOR GROUNDWATER MONITORING
AT
REFINED METALS CORPORATION SITE
U.S. EPA ID NUMBER IND000718130**

Prepared For:

**REFINED METALS CORPORATION
Beech Grove, Indiana**

Prepared By:

**ADVANCED GEOSERVICES CORP.
West Chester, Pennsylvania**

**Project No. 2003-1046-00
August 6, 2004
Revised January 26, 2006**



APPENDIX B

**QUALITY ASSURANCE PROJECT PLAN
FOR GROUNDWATER MONITORING
AT
REFINED METALS CORPORATION SITE
U.S. EPA ID NUMBER IND000718130**

Prepared For:

**REFINED METALS CORPORATION
Beech Grove, Indiana**

Prepared By:

**ADVANCED GEOSERVICES CORP.
West Chester, Pennsylvania**

**Project No. 2003-1046-00
August 6, 2004
Revised January 26, 2006**



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List of Persons Who Have Received This QAPP

**AGC
Refined Metals Corporation
Indiana DEM
U.S. EPA Region 5**



1.0 PROJECT DESCRIPTION

1.1 INTRODUCTION

On behalf of Refined Metals Corporation (RMC) Advanced GeoServices Corp. (AGC) has prepared this Quality Assurance Project Plan (QAPP) for the proposed groundwater monitoring activities at the RMC Facility in Beech Grove, Indiana (Site). This QAPP breaks out those portions of the EPA-approved QAPP appended to the RFI Work Plan dated March 3, 1999 that address groundwater monitoring. Except for the addition of analytical parameters and sampling events, no substantive changes have been made to the QAPP elements applicable to groundwater sampling. This QAPP contains a statement of the Data Quality Objectives (DQO), Sampling and Analysis Procedures, Quality Assurance/Quality Control Procedures, and Data Quality Analysis (DQA). A Health and Safety Plan (HASP) is provided as Appendix B.

1.2 QAPP PREPARATION GUIDELINES

This QAPP has been prepared in accordance with the Region 5 QAPP policy as presented in U.S. EPA RCRA QAPP Instructions, dated April 1998 and the Indiana Department of Environmental Management Risk Integrated System of Closure (RISC) dated February 2001.

1.3 OVERALL PROJECT OBJECTIVES AND DECISION STATEMENTS

Overall objectives of the data collection will be as follows:

- Define the presence, magnitude, extent, and mobility of hazardous waste and hazardous waste constituents in groundwater beneath the former site area and



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adjacent off-site areas that may have originated from the RCRA permitted hazardous waste or solid waste management units at the Site.

The groundwater sampling program outlined in the Groundwater Sampling Plan (GWSP) and the principles and procedures set forth in this QAPP are designed to ensure that data are of sufficient quality to perform comparisons with target decision levels and evaluate impact from the Interim Status Surface Impoundment at the facility. The Decision Statement for this investigation is as follows: identify the nature and extent of RCRA metals in groundwater attributable to the Surface Impoundment that present unacceptable risks, which would therefore warrant remedial action.

1.4 SITE/FACILITY DESCRIPTION

1.4.1 Location

The Refined Metals Corporation Site is located at 3700 Arlington Avenue, Beech Grove, Marion County, Indiana, in a zone of mixed land uses.

1.4.2 Facility/Site Size and Borders

The Site encompasses approximately 24 acres, and is bordered by a railroad spur on the north, a Firestone facility that manufactures roofing materials on the east (across Arlington Avenue), and a mix of vacant and industrial properties to the south. A Citizens Gas Storage facility and pipeline are located northwest of the Site, and a railroad yard and repair facility and Conrail and Amtrak are located beyond Citizens Gas toward the northwest.



1.4.3 Natural and Manmade Features

Section 3.0 of the RFI Work Plan discusses natural features on and surrounding the Site, and Section 2.0 of the RFI Work Plan describes the manmade features of the facility.

1.4.4 Topography

See Section 3.2 and Figure 3-1 of the RFI Work Plan for information concerning the Site topography and drainage.

1.4.5 Local Geology and Hydrogeology

See Sections 3.4 and 3.5 of the RFI Work Plan for information concerning the regional and local geology and hydrogeology of the Site.

1.4.6 Surrounding Land Use

See Section 3.3 of the RFI Work Plan for a discussion on surrounding land use.

1.4.7 Ecological Communities and Habitats

See Section 3.6 of the RFI Work Plan for a discussion of the ecological setting as determined through a site visit.



1.5 SITE/FACILITY HISTORY

1.5.1 General History

Refined Metals Corporation was engaged in recycling lead batteries and other lead wastes. There are currently no manufacturing operations at the facility. The plant was constructed in 1968 as a secondary lead smelter. In 1984, a battery breaker operation was installed. From April 14, 1995, through December 31, 1995, operations were reduced to enriching and casting lead ingots from off-specification lead products.

The facility was constructed to recycle lead batteries and other lead wastes. Automotive batteries constituted 90 percent of the materials recycled, and the remainder was waste material from battery manufacturers and other lead scrap. During operation, the batteries were temporarily stored in trailers or on pallets in a paved storage yard. The batteries were then fed into the battery crusher, where the tops of the batteries were sawed off and the sulfuric acid was drained into a stainless steel tank that drained to the wastewater treatment system. The battery casings and their contents were tumbled and crushed. Lead plates and other lead parts were separated and transported to the materials storage building to be later placed in the furnace. The battery casings were shredded and separated into plastic and rubber in a flotation tank. The plastic was blown into a trailer for sale to be sold to an off-site recycler. Rubber was stored and then fed into the blast furnace.

Before 1984, materials were stored on-site with minimal spill or runoff control. Storm water runoff from the storage piles and work areas flowed to the storage pond and evaporated; some runoff flowed off site to the north drainage ditch. Once the battery crusher was installed in 1984, a batch neutralization system was installed to treat acidic wastewater from the battery crushing and flotation systems. The wastewater was neutralized before discharging to Beech Grove Municipal Sanitary



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Sewer system. Since 1988, all stormwater has been contained and routed to the wastewater treatment system.

Reportedly, underground storage tanks (USTs) were never used at the Site. Three above ground storage tanks (ASTs) - two 10,000-gallon (ASTs) and one 20,000-gallon AST - were used to store diesel fuel for company trucks. The tanks were reportedly cleaned out in 1985 and are out of service. The three tanks are enclosed by a spill containment wall which was reportedly constructed before 1980. A 500-gallon AST and a 750-gallon AST were used for diesel fuel and gasoline, respectively, to fuel on-site vehicles. The 750-gallon gasoline tank is enclosed within a spill containment wall and pad. Propane, which is used to power forklifts, is stored in a 2,000-gallon tank.

A leak in a valve of one of the out-of-service diesel tanks occurred around 1983, resulting in a spill outside of the containment wall. A portion of the spill flowed along the drainage ditch located north of the refining area. The contaminated soil was excavated and the tanks were emptied. Although documentation of the spill is not available, the soil cleanup was reportedly conducted under state supervision.

1.5.2 Past Data Collection Activities

Low levels of arsenic, barium, chromium and lead have been detected in groundwater samples collected from the shallow Surface Impoundment wells. Prior data has been used as a screening tool to assist RMC in developing the proposed groundwater monitoring parameter list.



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1.5.3 Current Status

Since 1996, no production has taken place and the facility has been inactive.

1.6 PROJECT OBJECTIVES AND INTENDED DATA USAGES

For the purpose of groundwater monitoring it will be necessary to gather sufficient information to evaluate the nature and extent of releases from the Surface Impoundment, and also to determine whether unreasonable risks to human receptors are associated with groundwater impacts.

The groundwater monitoring activities will consist of:

- Low-flow groundwater sampling using shallow groundwater monitoring wells MW-5, MW-6SR, MW-9 (upgradient) and MW-12.

Data collection activities will specifically address the following concerns:

- The nature and extent of groundwater contamination; and,
- The impact of potential groundwater contamination on human health.

Parameters listed in Table 1-1 are the proposed critical measurement parameters for this project.

AGC risk assessment staff have reviewed the media sampling programs as proposed in the Groundwater Monitoring Plan and this QAPP to ensure that data collection activities will be in accordance with USEPA guidance for data quality objectives (USEPA 1987a,b).



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1.6.1 Project Target Parameters

Groundwater samples will be analyzed for metals (antimony, arsenic, iron, lead, and sodium), chloride, and sulfate. Groundwater samples collected during Phase I of the RFI were analyzed for certain VOCs, including tetrachloroethylene (PCE), 1,1,1-trichloroethane (TCA), benzene, toluene, and ethylbenzene. No VOCs were detected; therefore, no further analysis is proposed in subsequent groundwater sampling events. Sampling parameters and quantitation limits are listed on Table 1-1.

1.6.2 Field Parameters

Low-flow sampling indicator parameters such as temperature, pH, redox potential, dissolved oxygen, turbidity, and specific conductance will be monitored in the field during well purging (for monitoring wells) and at the time of sample acquisition to assure that the well has been adequately purged and that the groundwater is a representative sample from the aquifer.

1.7 SAMPLING LOCATIONS

Groundwater sampling will be performed in the three shallow groundwater monitoring wells already present at the Site plus one additional shallow groundwater monitoring well proposed in the GWMP. A figure showing the location of existing and proposed wells is provided in the GWMP.

1.8 PROJECT SCHEDULE

Groundwater sampling will be performed for four consecutive quarters. Thereafter groundwater sampling will be performed semi-annually until closure of the permitted RCRA units. Section 7.4 of the GWMP provides additional information about the analysis of sample results.



2.0 PROJECT ORGANIZATION AND RESPONSIBILITY

2.1 PROJECT ORGANIZATION CHART

The Refined Metals Corporation has selected Advanced GeoServices Corp., West Chester, Pennsylvania to be responsible for coordinating sampling and analysis activities and validating data received from the laboratory. TriMatrix Laboratories, Grand Rapids, Michigan, will conduct the chemical analyses of the samples. This laboratory possesses all credentials to do this work; qualifications and standard operating procedures were provided as Attachments to the RFI Work Plan QAPP.

While all personnel involved in the investigation and in the generation of data are implicitly a part of the overall project and quality assurance program, certain individuals have specific responsibilities. The key individuals who are responsible for the overall coordination of efforts to be conducted, as well as the collection, validation and interpretation of the data generated during this project, are identified in the following sections.

2.2 MANAGEMENT RESPONSIBILITIES

2.2.1 IDEM

Project Manager - Ruth Jean



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2.2.3 Advanced GeoServices Corp.

Project Manager - Paul G. Stratman, P.E., P.G.

Responsibilities of the AGC Project Manager include:

- Managing and coordinating site monitoring;
- Reviewing information;
- Initiating any GWMP or QAPP modifications;
- Providing in-house technical support for evaluating and organizing field data; and
- Providing input to the Task Managers on technical direction.

Task Manager - E. Terry Jensen

Responsibilities of the AGC Task Manager include:

- Managing and coordinating the tasks of the Investigator and technical staff personnel; and,
- Reviewing information obtained during the groundwater sampling.

2.3 QUALITY ASSURANCE RESPONSIBILITIES

2.3.1 Advanced GeoServices Corp.

Quality Assurance (QA) Manager - Jennifer Stanhope



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Responsibilities of the AGC QA Manager include:

- Performing data validation and assessment of the analytical data generated during sampling;
- Communicating analytical deficiencies found during data validation to the Project and Task Managers to initiate corrective action;
- Preparing data validation reports and tabulation of analytical data;
- Communicating with the laboratory for data deliverables and any problems with the data reported; and,

In addition, AGC Quality Assurance Scientists will be utilized to review chain-of-custodies, validate data, construct data summary tables, and perform data entry. The QA Scientists will report to the QA Manager.

2.4 LABORATORY RESPONSIBILITIES

2.4.1 TriMatrix Laboratories, Inc.

Laboratory Operations Manager

The Laboratory Operations Manager's responsibilities include:

- Liaison with sampling firm's Project Manager, Quality Assurance Manager, and laboratory technical staff;
- Production and efficiency of all departments including QA/QC;
- Recommendations of appropriate corrective action procedures to the QA Manager;
- Identification and supervision of appropriate and necessary support personnel; and



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- **Oversees final analytical results.**

Laboratory Program Manager

The responsibilities of the Laboratory Program Manager include:

- **Coordinates laboratory analyses;**
- **Supervises in-house chain-of-custody;**
- **Oversees data review and data assessment;**
- **Oversees preparation of analytical reports; and**
- **Approves final analytical reports prior to submittal to the Client.**

Laboratory Quality Assurance Supervisor (LQAS)

Responsibilities of the LQAS include:

- **Oversees QA/QC documentation;**
- **Inspecting and verifying laboratory QA/QC records and results;**
- **Implementing all laboratory QA/QC procedures contained in the QAPP;**
- **Overseeing corrective actions as required; and**
- **Conducting internal system and performance audits and inspection of analytical procedures.**



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Laboratory Sample Custodian

The Sample Custodian's responsibilities include:

- Providing sample bottles;
- Receiving and inspecting the incoming sample bottles;
- Recording the condition of the incoming sample containers;
- Verifying chain-of-custody and it's correctness;
- Notifying Laboratory Program Manager of sample receipt and inspection;
- Assigning an unique identification number and customer number and enters each into the sample receiving log; and
- Controlling and monitoring access/storage of samples.

Laboratory Technical Staff

The technical staff will be responsible for sample analysis and identification of corrective actions. The staff will report directly to the Laboratory Program Manager.

2.5 FIELD RESPONSIBILITIES

2.5.1 Advanced GeoServices, Corp.

On-Site Principle Investigator (PI)



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The PI's responsibilities include:

- **Providing full time field representation during field data collection activities;**
- **Collecting and reporting raw data; and,**
- **Overseeing any site contractors and other field personnel to ensure adherence to the GWMP and QAPP.**

Ensuring the appropriate QC samples are collected.

Field Technical Staff

The technical staff for this project will be drawn from AGC's pool of corporate resources. The technical staff will be utilized to gather and analyze data, and to prepare various task reports and support materials. All of the designated technical team members are experienced professionals who possess the degree of specialization and technical competence required to effectively and efficiently perform the required work.



3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

Data Quality Objectives (DQOs) are quantitative and qualitative statements specifying the quality of the environmental data required to support the decision making process. Separate DQOs are designed for field sampling and laboratory analysis so that clear distinctions between any problems found in the system can be isolated with respect to cause. Conversely, the DQOs are also designed to provide an indication of the variability of the overall system. The overall quality assurance objective is to keep the total uncertainty within an acceptable range that will not hinder the intended use of the data and to provide results which are legally defensible in a court of law. To achieve this, specific data requirements such as detection limits, criteria for precision and accuracy, sample representativeness, data comparability and data completeness (PARCC) are specified below. The DQOs for the RMC Site are presented in Tables 3-1 and 3-2.

3.1 PRECISION

3.1.1 Definition

Precision is a measure of the degree to which two or more measurements are in agreement.

3.1.2 Field Precision Objectives

Field precision is assessed through the collection and measurement of field duplicates at a rate of 1 duplicate per 10 analytical samples. The total number of duplicates for this project is found in Table 3-3 of this QAPP.



3.1.3 Laboratory Precision Objectives

Precision in the laboratory is assessed through the calculation of relative percent differences (RPD) and relative standard deviations (RSD) for three or more replicate samples. The equations to be used for precision in this project can be found in Section 12.2 of this QAPP. Precision control limits are provided in Table 3-2.

For inorganic analyses, laboratory precision shall be assessed through the analysis of a matrix spike and field duplicate pairs. All parameters of concern listed in Table 1-1 of this QAPP are included in method spiking solutions for MS analyses.

3.2 ACCURACY

3.2.1 Definition

Accuracy is defined as the degree of agreement of a measurement or average of measurements with an accepted reference value. Accuracy measures the bias in a measurement system which may result from sampling or analytical error. Sources of error that may contribute to poor accuracy are:

- laboratory error;
- sampling inconsistency;
- field and/or laboratory contamination;
- handling;
- matrix interference; and
- preservation.



3.2.2 Field Accuracy Objectives

Accuracy in the field is assessed through the use of field and trip blanks and through the adherence to all sample handling, preservation and holding times.

3.2.3 Laboratory Accuracy Objectives

Laboratory accuracy is assessed through the analysis of MS, laboratory control samples (LCS), and the determination of percent recoveries. Accuracy in laboratory methods and procedures will be evaluated by use of calibration and calibration verification procedures, and instrument performance solutions at the frequency specified in the USEPA "Test Methods for Evaluating Solid Waste Physical/Chemical Methods", April 1998, SW-846 5th edition (SW-846). The equation to be used for accuracy in this project can be found in Section 12.1 of this QAPP and "Methods of Chemical Analysis of Water and Wastes" March 1983. Accuracy control limits are given in Table 3-2. All parameters of concern included in Table 1-1 of this QAPP are included in method spiking solutions for the LCS and MS samples.

3.3 DATA COMPLETENESS

3.3.1 Definition

Completeness is defined as the percentage of data that is judged to be valid to achieve the objectives of the investigation compared to the total amount of data.



3.3.2 Field Completeness Objectives

Field completeness is a measure of the amount of valid measurements taken in the project. The equation for completeness is presented in Section 12.3 of this QAPP. The field completeness objective for this project will be greater than 90 percent.

3.3.3 Laboratory Completeness Objectives

Laboratory completeness is a measure of the amount of valid measurements obtained from all measurements taken in the project. The equation for completeness is presented in Section 12.3 of this QAPP. The laboratory completeness objective for this project, with respect to critical measurement parameters identified in Table 1-1, will be greater than 90 percent.

3.4 DATA REPRESENTATIVENESS

3.4.1 Definition

Representativeness expresses the degree to which sample data represent the characteristics of the environment from which they are collected. Samples that are considered representative are properly collected to accurately characterize the contamination at a sample location.

3.4.2 Measures to Ensure Representativeness of Field Data

Representativeness is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the GWMP is followed and that proper sampling techniques are used. Representativeness will be measured by using the field methods (e.g., sampling, handling, and



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preserving) in accordance with NEIC Policies and Procedures Manual and analytical methods in accordance with SW-846 methodologies.

3.4.3 Measures to Ensure Representatives of Laboratory Data

Representativeness in the laboratory is ensured by using the proper analytical procedures, appropriate methods, meeting sample holding times and analyzing and assessing field duplicate samples. The sampling network was designed to provide data representative of facility conditions. During development of this network, consideration was given to past waste disposal practices, the physical setting, and hydrogeologic conditions at the Site.

3.5 DECISION RULES

3.5.1 Definition

A Decision Rule is a statement which allows for a course of action or non-action to be taken, based on assumptions made to draw out and test its logical or empirical consequences.

3.5.2 Decision Rule Objectives

The decision rule objectives for this investigation address the definition of statistical parameter(s) characterizing the population, identification of action levels, and development of if/then statements defining conditions that would cause the decision maker to choose among alternate actions. The decision rule associated with groundwater monitoring is that if any of the critical measurement parameters listed in Table 1-1 are identified above human health levels in any of the monitoring wells, then the data will be used to define the extent of contamination or map the plume boundaries.



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The decision rule will be applied to validated data obtained from GWMP and RFI sampling activities with the following conditions:

- Sampling of the groundwater will not be performed until specific field parameters (i.e. redox potential, pH, specific conductance and dissolved oxygen) stabilize.

The decision rule will be used following the validation of GWMP data and the requirements for a baseline human health assessment and preliminary ecological risk assessment will be determined at that time.

3.6 COMPARABILITY

3.6.1 Definition

Comparability expresses the confidence with which one data set can be compared with another data set from a different phase or from a different program.

3.6.2 Measures to Ensure Comparability of Field Data

Comparability is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the SAP is followed and that proper sampling techniques are used.

3.6.3 Measures to Ensure Comparability of Laboratory Data

Comparability will be accomplished by ensuring that proper sample collection techniques will be utilized and through the use of standardized and approved methods of analysis.



3.7 LEVEL OF QUALITY CONTROL EFFORT

PARCC parameters will be monitored through the submission and analyses of various types of field and laboratory QC samples. These will include appropriate field blanks, equipment blanks, laboratory method blanks, field duplicates, matrix spikes, instrument performance solutions, and a careful examination of all calibration and check standards. Specifically:

- Field blanks and equipment blank consisting of distilled water will be submitted to the laboratory to provide the means to assess the quality of the data resulting from the field sampling program.
- Field blank samples are analyzed to check the procedural contamination at the facility which may cause sample contamination.
- Equipment blank samples are analyzed to check the decontamination procedural for field equipment which may attribute to cross contamination.
- Method blank samples are generated within the laboratory and used to assess contamination resulting from laboratory practices.
- Duplicate samples are analyzed to check for sampling and analytical reproducibility.
- MS are performed to provide information about the effect of the sample matrix on the digestion and measurement methodology.
- Instrument performance solutions, calibration and check standards are analyzed to assess the capability of the laboratory to perform the specific methods.

The frequency by which the field and laboratory QC samples will be prepared and submitted is specified in Section 8.0 of this QAPP. Table 3-3 summarizes the type and frequency of QC samples to be performed during this investigation. Sampling procedures for blanks and field duplicates are provided in Section 8.1.1 and 8.1.2. Quantitation limits for the critical measurement parameters are provided in Table 3-4.



4.0 SAMPLING PROCEDURES

Groundwater sampling is required to monitor the presence/absence and degree of metal constituents in groundwater at the Site. Specific sampling procedures are set forth in this section to meet the QA objectives outlined in Section 3.0 of this QAPP. The GWMP must be used concurrently with this QAPP during field sampling. SOPs are provided for the following RFI activities:

- Groundwater sampling;
- Field equipment decontamination; and,
- Sample handling.

4.1 GROUNDWATER SAMPLING

Groundwater sampling events will be conducted at four on-site monitoring wells.

4.1.1 Sampling Procedures

Detailed sampling procedures are provided in SOPs in Attachment B and include:

- Low-flow pump purging and sampling; and,
- Field parameter measurements.

Samples will be collected directly from the low-flow pump discharge line into laboratory provided sample containers or dedicated disposable filter units and then into laboratory prepared bottles (for dissolved metal analyses). Field parameter analyses will include, temperature, pH, specific conductance, redox potential, dissolved oxygen and turbidity, which will be measured using flow-through cells during well purging to determine if the well was adequately purged prior to sample



collection. Field blanks, equipment blanks, field duplicates, and matrix spike samples will be obtained as described in Section 8.1.

4.1.2 Sample Designation/Identification

Each sample will be assigned a sample designation according to a pre-determined numbering system. The sample designation at a minimum will include in abbreviated form: type of sample (i.e., MW) and a sample number. The sample designation will be written in indelible ink on an identification labels/tags and attached to the sample container. Sample labels/tags will also contain the items noted in Section 5.1.2.

4.1.3 Analytical Parameters

All samples collected will be analyzed for the parameters listed on Table 4-1. Table 4-1 lists the associated analytical methods, sample preservatives, sample container requirements, and holding times.

4.2 FIELD EQUIPMENT DECONTAMINATION

To prevent possible contamination from sampling equipment, all non-dedicated sampling devices will be decontaminated. Non-dedicated equipment is the low flow pump. Sampling equipment will be constructed of inert material (e.g., stainless steel, Teflon®). For non-dedicated equipment, field decontamination will be performed prior to its initial use, between sampling locations and between actual samples when more than one sample is to be collected at a given location. Decontamination is not required when dedicated equipment is used. All decontamination and subsequent use of decontaminated equipment will be documented in a field logbook.



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All non-dedicated sampling equipment will be decontaminated according to the following procedure:

1. Wash equipment thoroughly with a low phosphate detergent (Alconox) and water using a brush to remove any particulate matter or surface film.
2. Rinse equipment with distilled water.
3. Rinse with diluted nitric acid (10% N).
4. Triple rinse with distilled water.
5. Air dry equipment.
6. Wrap equipment in a clean plastic sleeve or in aluminum foil if not used immediately.

Spent nitric acid will be contained in a bucket and placed in drums.

4.3 SAMPLE HANDLING

4.3.1 Sample Containers

Sample containers will be provided to the sampling team by the laboratory sample custodian. All sample containers used in the course of this investigation will be new containers, pre-cleaned and certified as Level II or higher by I- CHEM Inc. Certificates of analysis are available from I-CHEM upon request. All bottles will be prepared by the laboratory with the appropriate preservative. After sample collection, containers will be labeled as specified in Section 5.1.2.



4.6.2 Sample Preservation and Holding Times

The laboratory will provide appropriately prepared sample containers for this project. The sample containers will be I-Chem bottles or the equivalent which are cleaned and preserved for the specific analysis. Aqueous samples for metals analyses will be preserved with nitric acid to pH<2. Samples for dissolved metals will be field filtered prior to preservation. All samples will be placed on ice and maintained at a temperature of approximately 4 degrees Celsius from the time of collection to the time of analysis.

The metals have a holding time limit of six months. Chloride and sulfate have a holding time limit of 28 days.



5.0 CUSTODY PROCEDURES

A sample is physical evidence collected from the project site. Due to the evidential nature of the data generated from sampling, sample custody must be traceable from the time the empty sample containers are prepared by the container supplier through the reporting of the results of the analyses. As an essential part of project management, sample control procedures have been established to ensure sample integrity. All sample containers and samples will be maintained under strict custody procedures throughout the investigation. Sample custody is addressed in three parts: field sample collection, laboratory analysis and final evidence files.

A sample, sample container, or evidence file will be considered under custody if:

- the item is in actual possession of a person; or
- the item is in the view of the person, after being in actual possession of the person; or
- the item was in the person's actual physical possession but is now locked up or sealed in a tamper-proof manner; or
- the item is placed in a designated secured restricted area.

5.1 FIELD CUSTODY PROCEDURES

Sample custody for samples collected during this investigation will be maintained by the field personnel collecting the samples. The field personnel are responsible for documenting each sample transfer and maintaining custody of all samples until they are shipped to the laboratory or archived.



5.1.1 Field Data Documentation/Field Logs

A system of logging all pertinent data collected during sampling operations will be maintained using dedicated bound field logbooks. Each page will be numbered, dated and initialed by the person making the entry. All entries will be made in indelible ink. Incorrect entries will be crossed out with a single line and verified with the recorder's initials. At the completion of the day, if a page is not complete, a diagonal line will be drawn through the remainder of the page with the notetaker's signature at the bottom.

All sample locations will be recorded and referenced to the site map so that each location is permanently established. Samples will be tagged with all pertinent site information at the time of sampling. Section 5.1.2 describes sample identification. Pertinent site information to be supplied in the field logbook for each task is listed below:

- Signature of notetaker;
- Name and location of investigation;
- Date and time of arrival and departure;
- Names of all personnel on-site and their affiliation;
- Purpose of the visit/description of field activity;
- All field instruments used, date and time of calibration and calibration checks, method of calibration, standards used;
- All field measurement results;
- Date, time, and location of all sampling points;



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- Method of sample collection;
- Any factors which could affect sample integrity;
- Name of sampler;
- Sample identification, sample description, sample preservation;
- Documentation of all conversations with the client, agency personnel, field decisions and approval; and
- Weather conditions.

Field logbooks should contain only factual information entered as real-time notes which will enable the user to recreate events on-site. They are a part of the project file and are admissible as evidence in litigation. In addition, chain-of-custody records will be prepared and kept as part of the field records.

5.1.2 Sample Identification

All sample bottles will be identified by the use of sample labels or tags with sample identification. Each sample will be labeled by the sampler to avoid any possibility of sample misidentification. Indelible ink shall be used to complete sample labels/tags. Each sample label/tag will be labeled at the time of collection with, at a minimum, the following information:

- Site specific project number and name;
- Date and time (military) of sample collection;
- Sample designation (location), note here if the sample is a QC sample or to be used for QC analysis;



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- Whether sample is a grab or composite;
- Presence of a preservative;
- Field representative(s) collecting the sample (Sampler); and
- Analyses requested.

The field sampler will maintain custody of samples following the procedures outlined in the following section until samples are properly relinquished to the laboratory or to a common carrier for delivery to the laboratory. Once at the laboratory, each sample will be assigned a unique laboratory identification number that will be used for analysis assignment, sample tracking, and data reporting while the samples are at the laboratory.

5.1.3 Chain-of-Custody Procedures

The following chain-of-custody procedures will be used for this project:

- New, certified clean sample containers will be prepared and relinquished by the laboratory on a chain-of-custody record. The chain-of-custody record will be used for all samples collected to document the sample custody transfer from person to person.
- Any transfer of custody of containers or samples will be noted on the chain-of-custody record.
- Each sample collected for the project will be entered on the chain-of-custody record.
- The chain-of-custody will be completed as soon as possible after sample collection. The following information must be supplied to complete the chain-of-custody record:
 - a. Site specific project name and number;



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- b. **Signature of samplers;**
 - c. **For each sample, sampling station number, date and time (military) of collection, grab or composite sample designation, and brief description of the type of sample and sampling location;**
 - d. **Number of sample containers per each sample location;**
 - e. **Analysis required;**
 - f. **Type of sample preservative;**
 - g. **Signatures of individuals involved in sample transfer (i.e., relinquishing and accepting samples). Individuals receiving the samples shall sign, date, and note the time that they received the sample on the record; and**
 - h. **Type of carrier service.**
- **The original chain-of-custody record will accompany the sample containers during transport to document their custody.**
 - **If custody is relinquished through a common parcel carrier for delivery to the laboratory, the following protocol will be followed:**
 - a. **The original completed chain-of-custody record will be placed inside the shipping package; and**
 - b. **The shipping package will be sealed with tape and custody seals affixed. The seals will be placed on the package in such a manner that the package cannot be opened without breaking the seals. The seals will serve to document that the shipping container was not opened during the shipment through the common parcel carrier.**

The chain-of-custody record is presented on Figure 5-1 of this QAPP.



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5.1.4 Sample Shipment Procedures

At the end of the sampling day, all samples for chemical analysis will be packaged in shipping containers for shipment to the analytical laboratory using the following steps:

1. Check each sample bottle for a properly completed sample identification label.
2. Place sample bottles from each location in separate plastic bags, then seal.
3. Ship the samples in a large capacity (waterproof metal or equivalent strength plastic) cooler, or specific laboratory-prepared sample shipping container. Place packing material (asbestos-free vermiculite, perlite, or Styrofoam beads) on the bottom of the cooler to prevent sample bottle breakage.
4. Place sample bottles in the shipping container in a manner that they do not touch and will not touch during shipment. Secure with packing material as needed to fill void space.
5. Maintain all samples at approximately 4°C during shipment. Use ice or freezer packs to cool the samples.
6. Place the original chain-of-custody record in a plastic bag, seal, and tape it to the inside of the shipping container lid.
7. Retain the pink copy of the chain-of-custody for the QA Manager.
8. Tape cooler drain shut. Tape the cooler or shipping container closed at a minimum of two locations.
9. Place two signed and dated custody seals across each edge of the shipping container.
10. Attach completed shipping label to the top of the cooler.
11. Relinquish the cooler to the courier with the required signed and dated handbill.



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12. Retain receipt of the handbill as part of the permanent documentation.

If the sample coolers are not shipped but instead picked up by the laboratory courier, step number 6 and 12 will be omitted and the chain-of-custody will be handed to and signed by the laboratory courier. The pink copy of the chain-of-custody will be maintained by the sampler and presented to the AGC QA Manager.

5.2 LABORATORY CUSTODY PROCEDURES

Laboratory custody procedure are outlined in Attachment B of the QAPP contained in the RFI Work Plan (dated March 1999), Laboratory Chain-of-Custody Standard Operating Procedure. Once the sample arrives at the laboratory, custody of the samples will be maintained by laboratory personnel. Upon receipt of the samples, the sample custody personnel will remove the chain-of-custody from the sealed cooler and sign and record the date and time on the chain-of-custody. The samples received will be verified to match those listed on the chain-of-custody. The laboratory will document and notify the Sampling Contractor's QA Manager immediately if any inconsistencies exist in the paperwork associated with the samples. The laboratory at a minimum will document the following stages of analysis: sample receipt, sample extraction/preparation, sample analysis, data reduction, and data reporting.

Samples will be given an unique laboratory identification number which is entered into the sample receiving log and the Laboratory Information Management System (LIMS). The analyst will enter the analytical data into the LIMS upon analysis completion and validation. The samples are placed into appropriate storage (refrigerators at 4°C) within an access controlled location. All samples are maintained under proper storage conditions for thirty days past the generation of the analytical report. The LIMS tracks the sample until completion of the report and invoice mailing. The data archived



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from the LIMS will be transferred to magnetic tape and retained for five years from the completion of sample analysis.

A chain-of-custody Sample Control Record is used as the documentation for the movement of chain-of-custody samples in and out of the access controlled storage. The analyst signs sample in and out each time a sample(s) is removed for any analysis. After all analyses are complete, the sample custodian files the form in the chain-of-custody project file. An example of the chain-of-custody Sample Control Record can be found on Figure 5-2.

Procedures for the custody of analytical data are outlined in Section 4.1, Attachment A. Sample disposal procedures are outlined in Section 4.2.4, Attachment A.

5.3 FINAL EVIDENCE FILES

The final evidence file will be a central repository for all documents which constitute evidence relevant to sampling and analysis activities as described in this QAPP. AGC is the custodian of the evidence file and maintains the contents of evident files for the investigation at the AGC West Chester office. The files will be maintained as mandated by the EPA and will be maintained for a minimum six years after the termination of the order. The final evidence file will contain at a minimum the following:

- Field logbooks;
- Photographs;
- Drawings;
- Laboratory data deliverables;
- Data validation reports;
- Progress reports; and



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- **Custody documentation.**



6.0 CALIBRATION PROCEDURES AND FREQUENCY

In order to provide high quality data, it is essential for all field and laboratory equipment to be in satisfactory operating condition. Thus, routine equipment calibration and maintenance is required.

6.1 FIELD INSTRUMENT CALIBRATION

During groundwater sampling, field measurements including pH, temperature, redox potential, dissolved oxygen, specific conductance and turbidity will be taken. Field calibration procedures, at a minimum, will include the following:

- Calibration of field instruments will be performed by trained technicians prior to mobilization of equipment to the site. All instruments will be calibrated as specified by the manufacturer. Standard solutions will also be checked to determine stability and operating conditions. All results of field calibrations and measurements will be maintained in bound site-dedicated logbooks assigned to the specific instrument and/or field logbooks at least daily when the instrument is in use. The recorded calibration information will include date and time of calibration, standards used, corrective actions taken if necessary, and calibration results. Routine field equipment maintenance will be documented in bound logbooks which will be kept with the field instruments.
- pH meters will be calibrated according to manufacturer's instructions prior to each use and will, at a minimum, consist of two standard buffer solutions (4, 7, or 10) obtained from chemical supply houses. Additionally, two standard buffer solutions will be analyzed as verification checks after every 20 samples and after each use. The verification check results must agree within ± 0.05 pH standard units or recalibration and reanalysis of all samples since the last verification check sample is required.



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- All field thermometers will be checked against a NIST or equivalent thermometer once a year. The temperature difference will be documented in a logbook and the field measurements will be adjusted accordingly. Temperature measurements will be recorded to $\pm 0.2^\circ \text{C}$.
- Dissolved oxygen meters are calibrated by a trained technician prior to use in the field using a 100 percent relative humidity chamber (air calibration method). A Winkler titration is performed to check the accuracy of the air calibration method. Dissolved oxygen meters will be calibrated in the field daily by the sampling personnel using the air calibration method.
- Specific conductance meters will be calibrated prior to each use using two potassium chloride solutions prepared by a qualified laboratory or chemical supplier. These solutions will bracket the levels of the samples. At a minimum, one of the solutions will be analyzed as a verification check after each sample location and at the end of the day. The verification check must be within $\pm 10\%$ of the true value. If the verification check is not within 10% of the true value, recalibration of the instrument is required and the last sample must be reanalyzed.
- Turbidity meters will be calibrated daily prior to use by using a standard of known turbidity provided by the manufacturer.

All calibration procedures performed will be documented in the field logbook and will include the date and time of calibration, name of the person performing the calibration, reference standards used, and the instrument readings.

6.2 LABORATORY INSTRUMENT CALIBRATION

Calibration procedures for a specific laboratory instrument will consist of initial calibrations, initial calibration verifications and continuing calibration verification. The SOP for each analysis performed in the laboratory describes the calibration procedures, their frequency, acceptance criteria and the conditions that will require recalibration. In all cases, the initial calibration will be verified



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using an independently prepared calibration verification solution. Specific laboratory instrument calibration requirements summarized in Table 6-1 outlined in Section 13.0 of each applicable laboratory SOP provided in Attachment B of the RFI Work Plan.

The laboratory maintains a sample logbook for each instrument. These logbooks contain the following information: instrument identification, date of calibration, analyst, calibration standards, and samples associated with these calibrations.

If equipment fails calibration or equipment malfunction is noted during calibration, the equipment is tagged and removed from service. The equipment is held out of service until repairs and successful calibration occur. All malfunctions, repairs and recalibrations are recorded in the appropriate instrument maintenance and calibration logs.



7.0 ANALYTICAL PROCEDURES

7.1 FIELD ANALYTICAL PROCEDURES

Temperature, redox potential, dissolved oxygen, turbidity, pH and specific conductance measurements of samples will be performed to determine if a well has been adequately purged. All field measurements will be collected according to manufacturer's instructions. Table 3-2 presents the quality control requirements and criteria for the field measurement parameters.

7.2 LABORATORY ANALYTICAL PROCEDURES

All sample media will be analyzed by TriMatrix Laboratories, Inc. TriMatrix is located at:

5560 Corporate Exchange Court SE
Grand Rapids, Michigan 49512
Telephone (616) 975-4500
Facsimile (616) 942-7463

The laboratory will conduct the analyses in accordance with the specified methods in Table 7-1. Only the most updated U.S. EPA methodology will be used. These methods have been selected because they are deemed sufficient to achieve the project data quality objectives. Standard Operating Procedures for the analyses are identified in Table 7-1 and are provided as attachments to the RFI Work Plan. These SOPs for sample preparation and analysis are based on the applicable USEPA Method. These SOPs provide sufficient detail and are specific to this investigation.



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The laboratory SOPs listed in Table 7-1 include a QA section which address the minimum QC requirements for analyses. All quality control samples identified in Section 8.0 will be analyzed as appropriate for each method. The quality control criteria as identified in the referenced U.S. EPA methods must be met or appropriate action will be taken. This may include termination of analysis, reanalysis of samples, or accepting the data and acknowledging a level of uncertainty.

7.2.1 Project Target Compounds and Laboratory Detection Limits

A complete listing of the project target analytes, quantitation limits and laboratory method detection limits is provided in Table 3-4.

7.2.2 List of Associated Quality Control Samples

Section 13.0 of the laboratory SOPs listed in Table 7-1 specifies the minimum QC requirements for the analysis of specific analyte groups. All project target analytes will be added to the spiking solution, in compliance with project requirements. Section 8.0 of this QAPP contains a complete listing of the associated QC samples for every analyte group and matrix.



8.0 INTERNAL QUALITY CONTROL CHECKS

Quality control and quality assurance procedures include both field and laboratory check samples and are designed to ensure and document the overall quality of the data. QA/QC checks detect potential problems at the source and, if necessary, trace the sample analytical pathways for introduction of contamination. The quality control data generated in the field will monitor sampling techniques, reproducibility, and cleanliness. Quality control data generated by the laboratory will monitor reproducibility (precision), cleanliness, and accuracy in analyzed samples. During data validation, QC check results are used to evaluate precision, accuracy, and representativeness of the overall sampling and analytical program.

8.1 FIELD QUALITY CONTROL CHECKS

The field quality control samples monitor the data quality as it is affected by the field procedures and conditions. Field QC samples are control samples that are introduced to the laboratory from the field. During field sampling efforts, different types of QA samples will be collected: field blanks, equipment blanks, field replicate and samples, matrix spike samples. The QC criteria for each field quality control sample are provided in Table 3-2. Validation guidelines outlined in Section 9.2 will be used for the acceptance limits of the field QC samples. Each type of QA sample is described below.

8.1.1 Field Blanks

Field blanks are collected in the field by pouring demonstrated analyte-free water provided from the laboratory from one sample container into a preserved sample container identical to those provided



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for sample collection. One field blank will be collected for each sampling round, and will be analyzed for the same parameters as the actual samples. Field blanks for dissolved metals will be filtered through a 0.45 μm filter prior to preservation.

8.1.2 Equipment Blanks

Equipment blanks are prepared in the field to ensure a sampling device (e.g., pump) has been effectively cleaned. The sampling equipment is filled with deionized water or deionized water is pumped through the device, transferred to the laboratory supplied sample bottles, preserved if necessary, and sent to the laboratory for analyses with the site samples. If dedicated equipment is not used, one equipment blank will be submitted for analyses for every 10 samples per media collected, and will be analyzed for the same parameters as the field samples. Equipment blanks for dissolved metals will be filtered through a 0.45 μm filter prior to preservation.

8.1.3 Field Duplicate Samples

Field duplicate samples consist of an actual sample taken in the field which has been split into two aliquots and put into two separate sampling containers. Aqueous samples will be obtained by alternately filling sample containers from the same sampling device for each parameter. The samples will be transported to the laboratory and analyzed as two separate samples. The results will be used to assess laboratory accuracy and precision of sampling and analysis.

Each sample will be labeled with a unique sample number and submitted to the laboratory for the appropriate analyses. Field duplicate samples determine analytical precision and sample



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representativeness. One field duplicate sample will be collected for every 10 samples per media collected.

8.1.4 Matrix Spike

Matrix spike (MS) samples will be submitted in association with metal analyses as further QC checks. MS will be collected from the same location as the field sample and in the same manner.

Each sample will be labeled with the sample number as the original sample, designated on the chain-of-custody as MS, and submitted to the laboratory for the appropriate analyses. MS samples determine accuracy by the recovery rates of the compounds added by the laboratory (all site related metal compounds will be included in the spiking solution). The MS samples also monitor any possible matrix effects specific to samples collected from the site and the extraction/digestion efficiency. One MS sample will be collected for every 20 samples per media collected and analyzed.

8.2 LABORATORY QUALITY CONTROL CHECKS

All QC procedures employed by the laboratory will be, at a minimum, equivalent to those required in the specified analytical methods. Laboratory QC checks are accomplished through the analyses of laboratory blanks, matrix spike, calibration verifications, laboratory fortified blanks and performance evaluation samples. When internal quality control results fall outside method acceptance criteria, the data will be reported, and the analysis repeated, flagged or accepted according to the specified analytical methods. The following sections generally describe internal laboratory quality control check samples. Quality control requirements are outlined in Section 18 of the laboratory SOPs contained in the RFI Work Plan QAPP.



8.2.1 Laboratory Blanks

Method/preparation blanks are generated within the laboratory during the processing of the actual samples. These blanks will be prepared using the same reagents and procedures and at the same time as the project samples are being analyzed. If contamination is found in the method blank, it indicates that similar contamination found in associated samples may have been introduced in the laboratory and not actually present in the samples themselves. Guidelines for accepting or rejecting data based on the level of contamination found in the blank are presented in the specified analytical method and laboratory SOPs.

A minimum of one method blank per 20 samples will be analyzed or, in the event that an analytical round consists of less than 20 samples, one method blank sample will be analyzed.

8.2.2 Instrument Blanks

Instrument blanks are prepared by the laboratory using deionized water for sample analysis. Instrument blanks are analyzed every ten samples to verify no cross contamination or baseline drifting has occurred. An instrument blank is generally analyzed after each calibration verification standard.

8.2.3 Matrix Spike

Matrix spike analyses are performed in association with the sample metal analyses. Matrix spikes are prepared by placing a known quantity of selected target analytes into a second aliquot of an actual field sample. All project target analytes will be included in the spiking solution. The spiking occurs



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prior to sample preparation and analysis. The matrix spike is then processed in a manner identical to the field sample. Recovery of each of the spiked compounds reflects the ability of the laboratory and method to accurately determine the quantity of that compound in that particular sample.

Matrix spike will be analyzed at a frequency of one pair per sample delivery group of up to 20 samples collected.

8.2.4 Calibration Verifications

Initial calibration of the instruments will be completed prior to sample analysis following the specified analytical methods and laboratory SOPs. Additionally, continuing calibration standards will be analyzed at least every tenth sample. Recalibration is required if the continuing calibration standards do not meet U.S. EPA method criteria. Specific calibration standard procedures are outlined in the laboratory Standard Operating Procedures (Attachment B of the RFI Work Plan).

8.2.5 Laboratory Control Sample (LCS)

The LCS is prepared by the laboratory by adding analytes of known concentrations to DI water for aqueous metals analysis. Reference materials with known concentrations are digested concurrent with samples for solid metals analyses. The LCS is designed to assess the capability of the laboratory to perform the analytical methods. If the analytes present in the LCS are not recovered within the criteria defined in the specified analytical methods, the samples will be redigested and reanalyzed or data will be flagged.



8.2.6 Performance Evaluation Samples

Performance testing evaluation (PT) samples are of known composition which has been provided to the laboratory for analysis by either an agency or client. The laboratory results are compared to the actual values to evaluate the laboratory's performance. Performance evaluation sample analyses are performed on a regular basis as required for the laboratory's certifications. Some PT programs which TriMatrix participates in are USEPA Water Pollution Performance Evaluation Study, ASI National Performance Evaluation Study and USEPA Water Supply Study.



9.0 DATA REDUCTION, VALIDATION AND REPORTING

9.1 DATA REDUCTION

9.1.1 Field Data Reduction Procedures

All field data will be written in ink into bound field logbooks immediately after measurements are taken. If errors are made, the error will be crossed out with a single line, initialed and dated with the corrections written clearly adjacent to the original entry.

9.1.2 Laboratory Data Reduction Procedures

All analytical data will be permanent, complete and retrievable. The analyst will record the analytical data in notebooks along with other pertinent information such as the laboratory ID number. Each page of the notebook shall be signed and dated by the analyst. Periodic review of the notebooks will be performed by a supervisor prior to final data reporting. Upon analysis completion and laboratory validation, the analyst will enter the analytical data into the LIMS.

The laboratory will report sample results on analysis report forms and provide the information described in USEPA SW-846 for all analyses for each package. A CLP-like data deliverables package is required. All laboratory data will undergo the data validation procedures described in the Laboratory QA Manual prior to final reporting. Data will be stored on the laboratory's network until the investigation is complete. Data archived from the LIMS will be transferred to magnetic tape which will be retained by the laboratory an additional five years, minimum.



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The equations that will be employed in reducing data are presented in Section 16 of the associated SOPs. The formulas included in the SOP make pertinent allowances for sample matrices. All calculations are checked by a second person prior to data entry into the LIMS. All groundwater metals results will be reported in micrograms per liter ($\mu\text{g/L}$) or milligrams per liter (mg/L). All blank results and QC data will be included in the data deliverables/package. Blank results will not be subtracted from the sample results. The blank results and QC data will be used in data validation to review sample results qualitatively. Data validation will be performed in general accordance with the guidelines identified in Section 9.2. Outliers and other questionable data will be addressed in the data validation report and specific QA/QC flags will be applied to questionable data. The QA/QC flags will be consistent with the USEPA data validation guidelines.

9.2 DATA VALIDATION

9.2.1 Procedures Used to Validate Field Data

Validation of the field data will be performed by the field technicians under the supervision of the QA manager. One hundred percent of the field analytical data will be validated. The procedures to validate the field data for this investigation include checking for transcription errors and review of logbook, on part of the field crew members. This task will be the responsibility of the lead field technician.

9.2.2 Procedures Used to Validate Laboratory Data

Validation of analytical data as received from the laboratory will be performed by the AGC QA Manager or QA Scientist. Validation will be performed on 100% of the analytical data in general



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accordance with the following data validation guidance document, where applicable: USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, Office of Emergency and Remedial Response, USEPA, Washington, D.C. July 2002 and IDEM Guidance to the Performance and Presentation of Analytical Chemistry Data (July 1998). The Data Management Plan, provided as Attachment C of the RFI Work Plan, discusses the specific procedures for the validation of CLP data. Quality control requirements specified in the methods will also be used to evaluate the data. Specific data validation procedures are outlined in Tables 9-1 through 9-3. Validation criteria are not met for any parameter, the associated samples will be qualified as indicated in Table 9-1.

The following presents definitions for the validation qualifiers:

- U - The analyte was analyzed for, but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection limit.
- J - The associated value is an estimated quantity.
- R - The data are unusable. (Note: The analyte may or may not be present.)
- UJ - The analyte was analyzed for, but was not detected. The associated detection limit is an estimate and may be inaccurate or imprecise.

The purpose of data validation is to assess the usability of the data by determining if the laboratory analyses met the PARCC criteria set by the site DQO's, the analytical method used and the guidance documents. Upon completion of data validation, the existing results will be reported in tabular form with data validation flags applied as appropriate to determine the usefulness of the data. The data validation flags will be consistent with the USEPA and IDEM data validation guidelines. A data validation report will be written to assist in making decisions based on the analytical results.



9.3 DATA REPORTING

Data validation reports, along with copies of all support documentation, validated data summary tables, and analytical data packages, will be submitted electronically and as a hard copy monthly to RMC Project Manager as data is validated as required by IDEM. The RMC Project Manager will forward to the IDEM, after adequate time for review, all documents, data and reports. The data validation report will be prepared.

9.3.1 Field Data Reporting

Field data reporting will be conducted through the transmission of logbook sheets containing tabulated results of all measurements made in the field, and documentation of all field activities.

9.3.2 Laboratory Data Reporting

The task of reporting laboratory data begins after the independent validation activity has been concluded. The AGC Quality Assurance Manager must perform a final review of the report summaries and case narratives to determine whether the report meets project requirements. In addition to the record of chain-of-custody, the report format shall consist of the following:

1. Case Narrative:
 - i. Date of issuance
 - ii. Laboratory analysis performed
 - iii. Any deviations from intended analytical strategy



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- iv. Laboratory batch number
- v. Numbers of samples and respective matrices
- vi. QC procedures utilized and also references to the acceptance criteria
- vii. Laboratory report contents
- viii. Project name and number
- ix. Condition of samples 'as-received'
- x. Discussion of whether or not sample holding times were met
- xi. Discussion of technical problems or other observations which may have created analytical difficulties
- xii. Discussion of any laboratory QC checks which failed to meet project criteria
- xiii. Signature of the Laboratory QA Manager

2. Chemistry Data Package:

- i. Case narrative for each analyzed batch of samples
- ii. Summary page indicating dates of analyses for samples and laboratory QC checks
- iii. Cross referencing of laboratory sample to project sample identification numbers
- iv. Description of data qualifiers to be used
- v. Sample preparation and analyses for samples
- vi. Sample results
- vii. Raw data for sample results and laboratory QC samples
- viii. Results of (dated) initial and continuing calibration checks



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- ix. MS recoveries, laboratory control samples, method blank results, and calibration check compounds
- x. Labeled (and dated) instrument data of sample results and laboratory QC checks
- xi. Copies of Nonconformance Reports

The data package submitted will be a "CLP-like" data package consisting of all the information presented in a CLP data package (but without the CLP forms).

All deliverables/packages from each laboratory must be paginated in ascending order. The laboratory must keep a copy of the paginated package in order to be able to respond efficiently to data validation inquiries. Any errors in reporting identified during the data validation process must be corrected by the laboratory as requested. All data validation inquiries to the laboratory must be addressed by a written response from the laboratory in question.

The deliverables will be provided to the AGC Quality Assurance Manager and will be made available to the EPA upon request.

9.4 DATA ACQUISITION REQUIREMENTS AND DATA QUALITY MANAGEMENT

Once the samples are collected and sent to the laboratory, the field sampler will send a copy of the chain-of-custody and field notes to the AGC Quality Assurance Manager. The chain-of-custodies will be checked for the appropriate analytical methods defined, parameters requested, number of samples collected and QC samples collected. The laboratory will be contacted if any information on the chain-of-custody is missing or incorrect. The CLP-like deliverables hard copy and electronic data will be provide to the AGC QA Manager. The QA Manager will perform an initial check to



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verify that all the samples were analyzed, the correct methods were used for analyses, all requested parameters were analyzed and samples were analyzed within the holding time requirements. The electronic deliverables will be downloaded into a site specific database and checked with the hard copy deliverables during the data validation process. A project status form will be completed each time a check level is performed. The project status form and check forms are included in Attachment D of the RFI Work Plan.

Analytical data, reports, and any other project related information produced during this project will be retained by AGC or its designee. Project reports, tables, etc. may be stored in project specific electronic files. On a regular basis, the data will be backed up on magnetic tapes and stored off-site. The files will be maintained as mandated by the EPA and will be maintained for a minimum six years after the termination of the order.



10.0 PERFORMANCE AND SYSTEM AUDITS AND FREQUENCY

Performance and system audits will be conducted to verify that sampling and analysis are performed in accordance with the procedures established in this QAPP.

10.1 FIELD PERFORMANCE AND SYSTEM AUDITS

10.1.1 Internal Audits

10.1.1.1 Internal Audit Responsibilities

Internal audits of field activities including sampling and field measurements will be conducted by the AGC QA Manager. These audits will verify that all established procedures are being followed.

10.1.1.2 Internal Audit Procedures

The audits will include a review of field sampling records, field screening analytical results, field instrument operating records, sample collection, handling and packaging in compliance with the established procedures, and maintenance of QA procedures, chain-of-custody, etc. by the AGC QA Manager in the AGC office at the completion of the round of sampling under the SAP. Follow-up discussion will be conducted with the field samplers to correct any deficiencies and to verify that QA procedures are maintained during subsequent sampling.



10.1.2 External Field Audits

10.1.2.1 External Field Audit Responsibilities

External field audits may be conducted by the IDEM.

10.1.2.2 External Field Audit Frequency

External field audits may be conducted any time during the field operations. These audits may or may not be announced and are at the discretion of IDEM.

10.1.2.3 External Field Audit Process

External field audits will be conducted according to the field activity information presented in the QAPP. The external field audit process can include (but not be limited to): sampling equipment decontamination procedures, sample bottle preparation procedures, sampling procedures, examination of field sampling and safety plans, sample vessel cleanliness and QA procedures, procedures for verification of field duplicates, sample preservation and preparation for shipment, as well as field screening practices.



11.0 PREVENTATIVE MAINTENANCE

11.1 FIELD INSTRUMENT PREVENTATIVE MAINTENANCE

Field measurement equipment, pH meters, thermometers, dissolved oxygen meters, and specific conductance meters will be maintained in accordance with manufacturer's instructions. All field equipment will be checked by qualified technicians prior to use in the field. The instrument operator will be responsible for ensuring that the equipment is operating properly prior to use in the field. Any problems encountered while operating the instrument will be documented in the field logbook. Critical spare parts such as batteries and pH probes will be kept on-site to reduce potential downtime. If problem equipment is detected or should require service, the equipment will be returned and a qualified technician will perform the maintenance required. Use of the instrument will not be resumed until the problem is resolved. Backup instruments and equipment will be available on-site or within 1 day shipment to avoid delays in the field activities. Routine maintenance of field instruments will be documented in bound logbooks which will be kept with the field instrument. Spare parts and the maintenance schedule are presented on Table 11-1.

11.2 LABORATORY INSTRUMENT PREVENTATIVE MAINTENANCE

Preventative maintenance and periodic maintenance is performed as recommended by the manufacturers of the equipment in use in the laboratory. Spare parts are kept in inventory to allow for minor maintenance.

The laboratory staff performs preventive maintenance and repairs or coordinates with a vendor for the repair of all instruments. All laboratory instruments are maintained in accordance with



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manufacturer's specifications and the requirements of the specific method employed. This maintenance is carried out on a regular, scheduled basis and is documented in the laboratory instrument service logbook for each instrument. Emergency repair or scheduled manufacturer's maintenance is provided under a repair and maintenance contract with factory representatives. The following Table 11-1 summarizes preventive maintenance schedules and critical spare parts inventories. Refer to the SOPs included in Attachment B of the RFI Work Plan for the preventative maintenance program for the ICP/MS and ICP.

11.3 INSPECTION/ACCEPTANCE REQUIREMENTS FOR SUPPLIES AND CONSUMABLES

Inspection/acceptance requirements for laboratory supplies and consumables are documented in Section 3.10, Attachment A of the RFI Work Plan.



12.0 SPECIFIC ROUTINE PROCEDURES USED TO EVALUATE DATA PRECISION, ACCURACY AND COMPLETENESS

The purpose of this section is to indicate the methods by which it will be ensured that the data collected for this investigation falls in line with the DQOs for the site.

Factors considered in this assessment include, but are not limited to:

- Possible future use of analytical results to conduct a groundwater specific Risk Assessment.
- The contaminants known and/or suspected to be of concern on a project as they relate to the data quality level parameters chosen.
- The choice of analytical and sample preparation methods for contaminants of concern whose method detection limits will meet or exceed the data quality level concentrations for those contaminants.

Once these goals and objectives are evaluated and chosen, analytical data quality will be assessed to determine if the objectives have been met. In addition, the data will be reviewed for indications of interferences to results caused by sample matrices, cross contamination during sampling, cross contamination in the laboratory, and sample preservation and storage anomalies (i.e., sample holding time).

12.1 ACCURACY ASSESSMENT

Accuracy will be calculated on the average percent recovery of spiked samples. In order to assure the accuracy of the analytical procedures, an environmental sample shall be spiked with a known



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amount of the project target analytes. At a minimum, one spike sample shall be included in every set of 20 samples analyzed on each instrument. The increase in concentration of the analyte observed in the spiked sample, due to the addition of a known quantity of the analyte, compared to the reported value of the same analyte in the unspiked sample determines the percent recovery. Accuracy is similarly assessed through determination of percent recoveries for laboratory control samples. Reference materials are essential to the evaluation of accuracy. Stock solutions for accuracy spikes and laboratory control samples shall be traceable to a source independent from the calibration standards. Accuracy is calculated using the equation below:

$$\%R = \frac{SSR - SR}{SA \times 100} \quad \text{or} \quad \frac{SR}{TV} = 100$$

Where:

$\%R$ = percent recovery

SSR = spiked sample result

SR = sample result

SA = amount of spike

TV = true value (actual mass)

12.2 PRECISION ASSESSMENT

The precision of field duplicate pairs or laboratory duplicate pairs will be expressed as relative percent difference (RPD) or relative standard deviation (RSD). RPD is derived from the absolute difference between duplicate analyses divided by the mean value of duplicates. The percent RSD is obtained by dividing the standard deviation by the average of the sample set. Equations for RPD and RSD are presented below:



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$$RPD = \frac{|D_1 - D_2|}{((D_1 + D_2)/2)} \times 100$$

Where:

D_1 and D_2 = two replicate values

$$RSD = \frac{S}{\bar{X}}; \text{ and } S = \left[\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{(n-1)} \right]^{1/2}$$

Where:

S = standard deviation

\bar{X} = average of sample set

x_i = each observed value

\bar{x} = the arithmetic mean of all observed values

n = total number of values

12.3 COMPLETENESS ASSESSMENT

Completeness is evaluated by dividing the total number of verifiable data points by the maximum number of data points possible and expressing the ratio as a percent. A usability criteria of 90 percent has been set for this project. Following completion of the analytical testing, the percent completeness will be calculated using the following equation:

$$\text{Completeness(\%)} = \frac{D}{P \times n} \times 100$$



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Where:

D = number of confident quantifications

P = number of analytical parameters per sample requested for analysis

n = number of samples requested for analysis

12.4 ASSESSMENT OF DATA

The field and laboratory data collected during this investigation will be used to evaluate groundwater flow and quality and determine whether past drainage areas have been affected. The QC results associated with each analytical parameter will be compared to the objectives presented in Sections 3.5 and 3.6 of this QAPP. Only data generated in association with QC results meeting these objectives will be considered usable for decision making purposes.

In addition, the data obtained will be both qualitatively and quantitatively assessed on a project-wide, matrix-specific, parameter specific and unit-specific basis. The assessment will be performed by the QA Manager and the results will be presented and discussed in detail in the final investigation report. Factors to be considered in this assessment of the field and laboratory data will include, but not necessarily be limited to, the following:

- Were all samples collected using the methodologies and SOPs proposed in the QAPP?
- Were all proposed analyses performed in accordance with the SOPs provided in this QAPP?
- Were samples obtained from all proposed sampling locations?



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- **Were samples received at the laboratory intact and within holding time requirements?**
- **Do any analytical results exhibit elevated detection limits due to matrix interferences or contaminants present at high concentrations?**
- **Were all data validated according to the validation documents proposed in this QAPP?**
- **Were any data found to be unusable (qualified as "R") based on the data validation results?**
- **Were any data found to be usable for limited purposes (qualified as "J") based on the data validation results?**
- **What affect due qualifiers applied as a result of data validation have on the ability to implement the project decision rules?**
- **Is data of sufficient quality to support possible future groundwater specific risk assessment?**
- **Can valid conclusions be drawn for each area under this investigation or is further sampling required?**
- **Were all issues requiring corrective action fully resolved?**
- **Based on the overall findings of the investigation and this assessment, were the original project objectives appropriately defined? If not, have revised project objectives been developed?**



13.0 CORRECTIVE ACTION

When field sampling activities or laboratory quality control results show the need for corrective action, immediate action will take place and will be properly documented. In the event that a problem arises, corrective action will be implemented. Any error or problem will be corrected by an appropriate action which may include:

- Replacing or repairing a faulty measurement system;
- Discarding erroneous data;
- Collecting new data; and
- Accepting the data and acknowledging a level of uncertainty.

13.1 FIELD CORRECTIVE ACTION

The lead field sampler will be responsible for all field quality assurance. Any out of protocol occurrence discovered during field sampling will be documented in the field notebook and immediate corrective action will be taken. For problems or situations which cannot be solved through immediate corrective action, the lead field sampler will immediately notify the Contractor's Project Manager. The AGC Project Manager/QA Manager and lead field sampler will investigate the situation and determine who will be responsible for implementing the corrective action. Corrective action will be implemented upon approval by the AGC Project Manager/QA Manager. The AGC Project Manager/QA Manager will verify that the corrective action has been taken, appears effective, and at a later date, verify that the problem has been resolved. The successfully implemented corrective action will be documented in the field logbook by the lead field sampler. Any deviations from the quality assurance protocol in the QAPP must be justified, approved by the AGC Project Manager/QA Manager (and the IDEM, if necessary), and properly documented.



13.2 LABORATORY CORRECTIVE ACTION

Corrective action will be implemented to correct discrepancies found which affect the validity or quality of analytical data and to identify any analytical data that may have been affected. Limits of data acceptability for each parameter and sample matrix are addressed in the instrument manuals, USEPA Methods and/or Laboratory QA Manual (Attachment A). Whenever possible, immediate corrective action procedures will be employed. All analyst corrective actions are to be followed according to the instrument manuals, USEPA Methods, or Laboratory QA Manual. Any corrective action performed by analyst will be noted in laboratory logbooks.

Laboratory personnel noting a situation or problem which cannot be solved through immediate corrective action, will notify the Laboratory QA Supervisor. The QA Supervisor will investigate the extent of the problem and its effect on the analytical data generated while the deficiency existed. All data suspected to be affected will be scrutinized to determine the impact of the problem on the quality of the data. If it is determined that the deficiency had no impact on the data, this finding will be documented. If the quality of the analytical data were affected, the Laboratory Program Manager and Contractor's Project Manager will be notified immediately so that courses of action may be identified to determine how to rectify the situation.

The laboratory must take corrective action if any of the quality control data generated during the laboratory analyses are outside the method criteria. Corrective action for out-of-control calibrations is to recalibrate the instrument and reanalyze the samples. A sequence is specified in the USEPA specified methods when problems in analyses are encountered. The laboratory will follow these procedures exactly and document the problems encountered and corrective action in a case narrative enclosed with each data deliverables package.



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The Laboratory QA Supervisor will be responsible for informing the Laboratory Program Manager and Sampling Contractor's Project Manager the effects on the data, the data affected and the corrective action taken. It is also the Laboratory QA Supervisor's responsibility to verify the corrective action was performed, appears effective, and at a later date, the problem was resolved.

Documentation of corrective actions taken by laboratory are outlined in Section 4, Attachment A of the RFI Work Plan. Reports will be completed to document nonconformances and the corrective actions taken. Copies of nonconformance reports will be included as part of the laboratory deliverable for this project.

13.3 CORRECTIVE ACTION DURING DATA VALIDATION AND DATA ASSESSMENT

Upon completion, sample data packages will be sent from the laboratory to the AGC QA Manager for data validation. If all project samples are not present in the data packages or any deficiencies affecting the sample results are noted, the QA Manager will contact the Laboratory Program Manager. The Laboratory Program Manager will consult with the Laboratory QA Supervisor and respond in writing to any inquiries and provide any changes to the data packages to the QA Manager. Any errors, problems, questionable data values, or data values outside established control limits will be corrected by the appropriate action which may include disregarding erroneous data, collecting new data, and accepting the data and acknowledging a level of uncertainty. The data validation report will provide a description of the usability of the data.



**TABLE 1-1
REFINED METALS SITE PROJECT ANALYTE LIST**

Constituent	Matrix	Human Health Data Quality Level ¹	Ecological Data Quality Level ²	Quantitation Limit
Antimony	Aqueous	6 µg/L	NA	1 µg/L
Arsenic	Aqueous	0.045 µg/L*	NA	1 µg/L
Iron	Aqueous	11,000 µg/L	NA	100 µg/L
Lead	Aqueous	4 µg/L	NA	1 µg/L
Sodium	Aqueous	NA	NA	500 µg/L
Chloride	Aqueous	NA	NA	1 mg/L
Sulfate	Aqueous	NA	NA	5 mg/L

* For these parameters, analytical sensitivity is inadequate to meet target decision levels. Therefore, for risk assessment purposes, non-detect data shall be considered as equal to one-half the reporting limit.

1 USEPA Region 9 Preliminary Remediation Goals (PRGs), 1998.

2 USEPA Region 5 Ecological Data Quality Levels.



TABLE 3-1
REFINED METALS SITE
DATA QUALITY OBJECTIVES

DQO Parameter	Laboratory Parameters	Field Parameters¹
Accuracy	Table 3-2	Table 3-2
Precision	Table 3-2	Table 3-2
Completeness	90%	100%
Comparability	Based on precision, accuracy, and media comparison	Based on precision, accuracy, and media comparison

Note

- 1 Indicator parameters include: specific conductance, temperature, dissolved oxygen, redox potential, and pH.



TABLE 3-2
REFINED METALS SITE
ACCURACY AND PRECISION DATA QUALITY OBJECTIVES FOR
LABORATORY AND FIELD PARAMETERS

Audit	Parameter	Analytes	Control Limits
Accuracy	Laboratory Blank	Metals Chloride Sulfate	$< \pm \text{LOQ}$
	Field/Equipment Blank	Metals Chloride Sulfate	$< \pm \text{LOQ}$
	Matrix Spike Recovery	Metals Chloride Sulfate	75-125 %, unless the sample concentration is greater than 4 times the amount of spike added
	Laboratory Control Sample	Metals Chloride Sulfate	80-120%
Precision	Matrix Spike	Metals Chloride Sulfate	$< 20\%$ RPD for results $> 5 \times \text{LOQ}$ or $< \pm \text{LOQ}$ for results $< 5 \times \text{LOQ}$
	Field Duplicate	Metals Chloride Sulfate	$< 25\%$ RPD for both results $> 5 \times \text{LOQ}$, $< \pm 1.5 \times \text{LOQ}$ for both results $< 5 \times \text{LOQ}$, $< \pm 1.5 \times \text{LOQ}$ for one result $< 5 \times \text{LOQ}$ and the other $> 5 \times \text{LOQ}$
Accuracy/Precision Standard Checks	Field Parameters	pH Specific Conductance Turbidity Dissolved Oxygen Redox Potential Temperature	± 0.05 pH units $\pm 10\%$ RPD $\pm 2\%$ NTU ± 0.3 mg/L ± 0.1 mg/L ± 0.2 °C

Note

LOQ Limit of Quantitation

Metals (Antimony, Arsenic, Iron, Lead, Manganese, Sodium)

**TABLE 3-3
REFINED METALS SITE
SAMPLING AND ANALYSIS PROGRAM SUMMARY**

Sample Location	Matrix	Parameters	Number of Samples ²	Field Duplicate	Matrix Spike	Blank ¹	Total Number of Samples ²
Monitoring Wells	Groundwater (rounds 1-4)	Field Turbidity pH Redox potential Specific conductance Temperature Dissolved Oxygen	12 ³	NA	NA	NA	12
		Laboratory Metals (Sb, As, Fe, Pb, Mn, Na)	4	1	1	2	8
		Chloride	4	1	1	2	8
		Sulfate	4	1	1	2	8
	Groundwater (all subsequent rounds)	Field Turbidity PH Redox potential Specific conductance Temperature Dissolved Oxygen	12 ³	NA	NA	NA	12
		Laboratory Metals (Sb, As, Pb)	4	1	1	2	8

Notes

- 1 Blank total includes estimated number of field and equipment blanks.
- 2 Total number of samples per event.
- 3 This number reflects the fewest number of samples to be taken.





TABLE 3-4
REFINED METALS SITE PROJECT ANALYTE LIST
QUANTITATION LIMITS

Parameters	Method ¹	Method Detection Limit	Quantitation Limit ²	Laboratory Standard Operating Procedure
Antimony	SW-846 3010A/6020	0.682 µg/L	1.0 µg/L	GR-01-121/GR-01-129
Arsenic	SW-846 3010A/6020	0.239 µg/L	1.0 µg/L	GR-01-121/GR-01-129
Iron	SW-846 3010A/6010	7.72 µg/L	100 µg/L	GR-01-121/GR-01-100
Lead	SW-846 3010A/6020	0.231 µg/L	1.0 µg/L	GR-01-121/GR-01-129
Sodium	SW-846 3010A/6010	231 µg/L	500 µg/L	GR-01-121/GR-01-100
Chloride	MCAWW 325.2	0.386 mg/L	1.0 mg/L	GR-02-104
Sulfate	MCAWW 375.4	0.152 mg/L	5.0 mg/L	GR-05-108

Notes

- 1 Methods listed are from USEPA "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods" April 1998, SW-846, Fifth Edition and USEPA "Methods for Chemical Analysis of Water and Wastes" March 1983.
- 2 Specific quantitation limits are highly matrix-dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable.

**TABLE 4-1
REFINED METALS SITE
PARAMETER TABLE**

Parameter	Matrix	Method	Container Type	Preservative	Holding Time
Temperature, pH, Redox Potential, Dissolved Oxygen, Specific Conductance	Aqueous	Manufacturer's Instructions	NA	NA	Analyze Immediately
Antimony, Arsenic, Iron	Aqueous	USEPA SW-846 3010A/6020A ²	1 Liter HDPE	HNO ₃ to pH<2 Cool 4°C ± 2°C	180 Days
Lead, Sodium		USEPA SW-846 3010A/6010B ²			
Chloride	Aqueous	MCAWW 352.2 ³	1 Liter HDPE	Cool 4°C ± 2°C	28 Days
Sulfate	Aqueous	MCAWW 375.2 ³			28 Days

Notes

NA Not applicable

HDPE High density polyethylene plastic

HNO₃ Nitric acid

- 1 Includes total and dissolved metals. Dissolved metals will be field filtered prior to preservation.
- 2 USEPA "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods," April 1998, SW-846, Fifth Edition
- 3 USEPA "Methods for Chemical Analysis of Water and Wastes," March 1983



**TABLE 6-1
SUMMARY OF LABORATORY CALIBRATION REQUIREMENTS**

Method	Parameter	QC Check	Minimum Frequency	Acceptance Criteria
SW-846 6020A (ICP-MS)	Antimony, Arsenic, Lead	Instrument Detection Limit (IDL) Determination	Every three months	SW-846 6020 Paragraph 8.2
		Internal Standards	Monitor during every analysis	Within $\pm 20\%$ of the original calibration solution
		Initial Calibration (minimum 1 standard and a blank)	Daily initial calibration prior to sample analysis	90-110% recovery for each parameter
		Calibration Verification (second source standard)	Before beginning a sample run, after every 10 samples and at the end of the analysis sequence	90-110% recovery for each parameter
		Instrument Blank (calibration blank)	Before beginning a sample run, after every 10 samples and at the end of the analysis sequence	No analyte detected \geq LOQ
		Method Blank (preparation blank)	One method blank for each group of 10 samples.	No analyte detected \geq LOQ
		Matrix Spike (MS)	One MS for each group of 10 samples.	75-125%
		Duplicate Sample Analysis	One duplicate for each group of 10 samples.	RPD $\leq 20\%$
		Laboratory Control Sample (LCS)	One LCS for each group of 10 samples.	80-120%
		Serial Dilution	One dilution test for each group of 20 samples.	Within $\pm 10\%$ of the original determination
		ICP Interference Check Solutions (ICS-A and ICS-AB)	Perform at the beginning of an analytical run or once every 12 hours, whichever is more frequent.	80-120%
		Post Digestion Spike	SW-846 6020 Paragraph 8.6	75-125%
		ICP Interelement Correction Factors	Annually	SW-846 6020 Paragraph 8.4
		MS Tuning Sample	Prior to calibration and analysis	95-105%
SW-846 6010B (ICP)	Iron, Sodium	Instrument Detection Limit (IDL) Determination	Quarterly	SOP GR-01-100, p.30
		Instrument Profile	Run before initial calibration	70-130% from the recorded value
		Instrument Calibration	Run before initial calibration	$r^2 \geq 0.995$
		Initial Calibration (minimum 1 standard and a blank)	Daily initial calibration prior to sample analysis	90-110% recovery for each parameter
		Calibration Verification (second source standard)	Before beginning a sample run, after every 10 samples and at the end of the analysis sequence	90-110% recovery for each parameter



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Method	Parameter	QC Check	Minimum Frequency	Acceptance Criteria
		Instrument Blank (calibration blank)	Before beginning a sample run, after every 10 samples and at the end of the analysis sequence	No analyte detected \geq LOQ
		Method Blank (preparation blank)	One method blank for each group of 10 samples.	No analyte detected \geq LOQ
		Matrix Spike (MS)	One MS for each group of 20 samples.	75-125%
		Duplicate Sample Analysis	One duplicate for each group of 10 samples.	RPD \leq 10%
		Laboratory Control Sample (LCS)	One LCS for each group of 10 samples.	90-110%
		Serial Dilution	One dilution test for each group of 20 samples.	Within \pm 10% of the original determination
		ICP Interference Check Solutions (ICSA-1 and ICSA-2)	Perform at the beginning of an analytical run or once every 12 hours, whichever is more frequent.	80-120% spiked elements \pm 2*LOQ unspiked elements
		Contract Required Detection Limits (CRDL)	After initial calibration blank and before ICSA-1	80-120%
		Laboratory Fortified Blank (LFB)	One per sample batch.	75-125%
		Post Digestion Spike	One for each group of 20 samples.	80-120%
		ICP Interelement Correction Factors	Every six months	80-120%
MCAWW 325.2 MCAWW 375.2	Chloride Sulfate	Initial Calibration (minimum 6 standards and a blank)	Daily initial calibration prior to sample analysis	$r^2 \geq 0.9990$
		Calibration Verification (second source standard)	Before beginning a sample run, after every 10 samples and at the end of the analysis sequence	85-115% recovery for each parameter
		Instrument Blank (calibration blank)	Before beginning a sample run, after every 10 samples and at the end of the analysis sequence	No analyte detected \geq LOQ
		Method Blank (preparation blank)	One method blank for each group of 10 samples.	No analyte detected \geq LOQ
		Matrix Spike (MS)	One MS for each group of 10 samples.	70% - 125%
		Duplicate Sample Analysis	One duplicate for each group of 10 samples.	RPD \leq 20%
		Detection Limit Confirmation Sample (CRL)	One per run	80-120%
		Laboratory Control Sample (LCS)	One LCS for each group of 10 samples.	85% - 115%



TABLE 9-1
SUMMARY OF DATA VALIDATION REQUIREMENTS

Method	Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Qualifier Requirements
6020A	Antimony, Arsenic, Lead	Instrument Detection Limit (IDL) Determination	Every three months	SW-846 6020 Paragraph 8.2	Apply R to all results for specific analyte(s) without a current IDL determination.
		Internal Standards	Monitor during every analysis	Within $\pm 20\%$ of the original calibration solution	Apply R to all results for specific analyte(s) not monitored for internal standards.
		Initial Calibration (minimum 1 standard and a blank)	Daily initial calibration prior to sample analysis	90-110 %R for each parameter	Apply R to all results for specific analyte(s) for all samples associated with the calibration if calibration not performed. If percent recovery (%R) is $<90\%$, apply J/UJ. If %R is $>110\%$, apply J. If %R is $<75\%$ or $>125\%$, apply R to all positive results.
		Calibration Verification (second source standard)	Before beginning a sample run, after every 10 samples and at the end of the analysis sequence	90-110 %R for each parameter	Apply R to all results for specific analyte(s) for all samples associated with the calibration if calibration not performed. If %R is $<90\%$, apply J/UJ. If %R is $>110\%$, apply J. If %R is $<75\%$ or $>125\%$, apply R to all positive results.
		Instrument Blank (calibration blank)	Before beginning a sample run, after every 10 samples and at the end of the analysis sequence	Not detected \geq LOQ	Apply R to all results for all analytes for all samples without an associated calibration blank. If sample concentration is $<5 \times$ blank concentration, result will be qualified U.
		Method Blank (preparation blank)	Analyze one method blank for each group of 10 samples.	Not detected \geq LOQ	Apply R to all results for specific analytes for all samples without an associated method blank. If sample concentration is $<10 \times$ blank concentration, result will be qualified U.
		Matrix Spike (MS)	Analyze one MS for each group of 10 samples.	75 – 125%	Professional judgement will be used to determine if associated sample data should be qualified when frequency is not met. If %R is $<75\%$, apply J/UJ. If %R is $>125\%$, apply J. If %R is $<30\%$, apply R to all results.



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Method	Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Qualifier Requirements
		Duplicate Sample Analysis	One duplicate sample for each group of 20 samples.	If results >5X LOQ, RPD ≤ 20% If results <5X LOQ, ±LOQ value	Professional judgement will be used to determine if associated sample data should be qualified when frequency is not met. Apply J to all sample concentrations if acceptance criteria are not met.
		Laboratory Control Sample (LCS)	One LCS for each group of 10 samples or each batch, whichever is more frequent.	80 - 120%	Professional judgement will be used to determine if associated sample data should be qualified when frequency is not met. If %R is <80%, apply J/UJ. If %R is >120%, apply J. If %R is <50%, apply R to all results.
		Serial Dilution	One dilution test for each group of 20 samples.	Within ± 10% of the original determination	Professional judgement will be used to determine if associated sample data should be qualified when frequency is not met. Apply J to associated sample concentrations if acceptance criteria are not met and sample concentration is >50 * IDL.
		ICP Interference Check Solutions (ICS-A and ICS-AB)	At the beginning of an analytical run or once every 12 hours, whichever is more frequent.	80 - 120%	Professional judgement will be used to determine if associated sample data should be qualified when frequency is not met. If %R is <80%, apply J/UJ. If %R is >120%, apply J. If %R is <50%, apply R to all results.
		Post Digestion Spike	SW-846 6020 Paragraph 8.6	75 - 125%	Professional judgement will be used to determine if associated sample data should be qualified when frequency is not met. If %R is <75%, apply J/UJ. If %R is >125%, apply J. If %R is <30%, apply R to all results.
		MS Tuning Sample	Prior to calibration and analysis	SW-846 6020 paragraph 5.8	Apply R to all results for all analytes for all samples associated with the MS tuning.
		Holding Time Specifications	NA	180 days from sample collection to analysis	Apply J/UJ to all samples analyzed after holding time has elapsed. Professional judgement will be used to determine if associated sample data should be rejected when holding time is grossly exceeded.



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Method	Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Qualifier Requirements
6010B	Iron, Sodium	Field Duplicate Analysis	1 per 10 samples collected	If results $>5 \times \text{LOQ}$, $\text{RPD} \leq 25\%$ If results $<5 \times \text{LOQ}$, $\pm 1.5 \times \text{LOQ}$ value	Professional judgement will be used to determine if associated sample data should be qualified when frequency is not met. Apply J to all sample concentrations if acceptance criteria are not met.
		IDL Determination	Every three months	SW-846 6020 Paragraph 8.2	Apply R to all results for specific analyte(s) without a current IDL determination.
		Instrument Detection Limit (IDL) Determination	Every three months	SOP GR-01-100, p.30	Apply R to all results for specific analyte(s) without a current IDL determination.
		Internal Standards	Monitor during every analysis	Within $\pm 20\%$ of the original calibration solution	Apply R to all results for specific analyte(s) not monitored for internal standards.
		Initial Calibration (minimum 1 standard and a blank)	Daily initial calibration prior to sample analysis	90-110 %R for each parameter	Apply R to all results for specific analyte(s) for all samples associated with the calibration if calibration not performed. If percent recovery (%R) is $<90\%$, apply J/UJ. If %R is $>110\%$, apply J. If %R is $<75\%$ or $>125\%$, apply R to all positive results.
		Calibration Verification (second source standard)	Before beginning a sample run, after every 10 samples and at the end of the analysis sequence	90-110 %R for each parameter	Apply R to all results for specific analyte(s) for all samples associated with the calibration if calibration not performed. If %R is $<90\%$, apply J/UJ. If %R is $>110\%$, apply J. If %R is $<75\%$ or $>125\%$, apply R to all positive results.
		Instrument Blank (calibration blank)	Before beginning a sample run, after every 10 samples and at the end of the analysis sequence	Not detected $\geq \text{LOQ}$	Apply R to all results for all analytes for all samples without an associated calibration blank. If sample concentration is $<5 \times$ blank concentration, result will be qualified U.
		Method Blank (preparation blank)	Analyze one method blank for each group of 10 samples.	Not detected $\geq \text{LOQ}$	Apply R to all results for specific analytes for all samples without an associated method blank. If sample concentration is $<10 \times$ blank concentration, result will be qualified U.



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Method	Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Qualifier Requirements
		Matrix Spike (MS)	Analyze one MS for each group of 10 samples.	75 - 125%	Professional judgement will be used to determine if associated sample data should be qualified when frequency is not met. If %R is <75%, apply J/UJ. If %R is >125%, apply J. If %R is <30%, apply R to all results.
		Duplicate Sample Analysis	One duplicate sample for each group of 20 samples.	If results >5X LOQ, RPD ≤ 20% If results <5X LOQ, ±LOQ value	Professional judgement will be used to determine if associated sample data should be qualified when frequency is not met. Apply J to all sample concentrations if acceptance criteria are not met.
		Laboratory Control Sample (LCS)	One LCS for each group of 10 samples or each batch, whichever is more frequent.	80 - 120%	Professional judgement will be used to determine if associated sample data should be qualified when frequency is not met. If %R is <80%, apply J/UJ. If %R is >120%, apply J. If %R is <50%, apply R to all results.
		Serial Dilution	One dilution test for each group of 20 samples.	Within ± 10% of the original determination	Professional judgement will be used to determine if associated sample data should be qualified when frequency is not met. Apply J to associated sample concentrations if acceptance criteria are not met and sample concentration is >50 * IDL.
		ICP Interference Check Solutions (ICSA-1 and ICSA-2)	At the beginning of an analytical run or once every 12 hours, whichever is more frequent.	80 - 120%	Professional judgement will be used to determine if associated sample data should be qualified when frequency is not met. If %R is <80%, apply J/UJ. If %R is >120%, apply J. If %R is <50%, apply R to all results.
		Post Digestion Spike	SW-846 6020 Paragraph 8.6	75 - 125%	Professional judgement will be used to determine if associated sample data should be qualified when frequency is not met. If %R is <75%, apply J/UJ. If %R is >125%, apply J. If %R is <30%, apply R to all results.
		Holding Time Specifications	NA	180 days from sample collection to analysis	Apply J/UJ to all samples analyzed after holding time has elapsed. Professional judgement will be used to determine if associated sample data should be rejected when holding time is grossly exceeded.



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Method	Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Qualifier Requirements
325.2 375.2	Chloride Sulfate	Field Duplicate Analysis	1 per 10 samples collected	If results $>5*LOQ$, $RPD \leq 25\%$ If results $<5*LOQ$, $\pm 1.5*LOQ$ value	Professional judgement will be used to determine if associated sample data should be qualified when frequency is not met. Apply J to all sample concentrations if acceptance criteria are not met.
		IDL Determination	Every three months	SW-846 6020 Paragraph 8.2	Apply R to all results for specific analyte(s) without a current IDL determination.
		Initial Calibration (minimum 1 standard and a blank)	Daily initial calibration prior to sample analysis	≥ 0.0990	Apply R to all results for specific analyte(s) for all samples associated with the calibration if calibration not performed. If correlation coefficient is <0.0990 , apply J/R.
		Calibration Verification (second source standard)	Before beginning a sample run, after every 10 samples and at the end of the analysis sequence	85-115%R for each parameter	Apply R to all results for specific analyte(s) for all samples associated with the calibration if calibration not performed. If %R is $<90\%$, apply J/UJ. If %R is $>110\%$, apply J. If %R is $<75\%$ or $>125\%$, apply R to all positive results.
		Instrument Blank (calibration blank)	Before beginning a sample run, after every 10 samples and at the end of the analysis sequence	Not detected $\geq LOQ$	Apply R to all results for all analytes for all samples without an associated calibration blank. If sample concentration is less than 5 times the blank concentration, result will be qualified U.
		Method Blank (preparation blank)	One method blank for each group of 10 samples.	Not detected $\geq LOQ$	Apply R to all results for specific analytes for all samples without an associated method blank. If sample concentration is $<10 * \text{blank concentration}$, result will be qualified U.
		MS	One MS for each group of 10 samples.	75 – 125%	Professional judgement will be used to determine if associated sample data should be qualified when frequency is not met. If %R is $<75\%$, apply J/UJ. If %R is $>125\%$, apply J. If %R is $<30\%$, apply R to all results.
		Duplicate Sample Analysis	One duplicate for each group of 20 samples.	If results $>5*LOQ$, $RPD \leq 20\%$ If results $<5*LOQ$, $\pm LOQ$ value	Professional judgement will be used to determine if associated sample data should be qualified when frequency is not met. Apply J to all sample concentrations if acceptance criteria are not met.



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Method	Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Qualifier Requirements
		LCS	One LCS for each group of 10 samples or each batch, whichever is more frequent.	85-115%	Professional judgement will be used to determine if associated sample data should be qualified when frequency is not met. If %R is <80%, apply J/UJ. If %R is >120%, apply J. If %R is <50%, apply R to all results.
		Holding Time Specifications	NA	28 days from sample collection to analysis	Apply J/UJ to all samples analyzed after holding time has elapsed. Professional judgement will be used to determine if associated sample data should be rejected when holding time is grossly exceeded.
		Field Duplicate Analysis	1 per 10 samples collected	If results >5*LOQ, RPD ≤ 25% If results <5*LOQ, ±1.5 X LOQ value	Professional judgement will be used to determine if associated sample data should be qualified when frequency is not met. Apply J to all sample concentrations if acceptance criteria are not met.





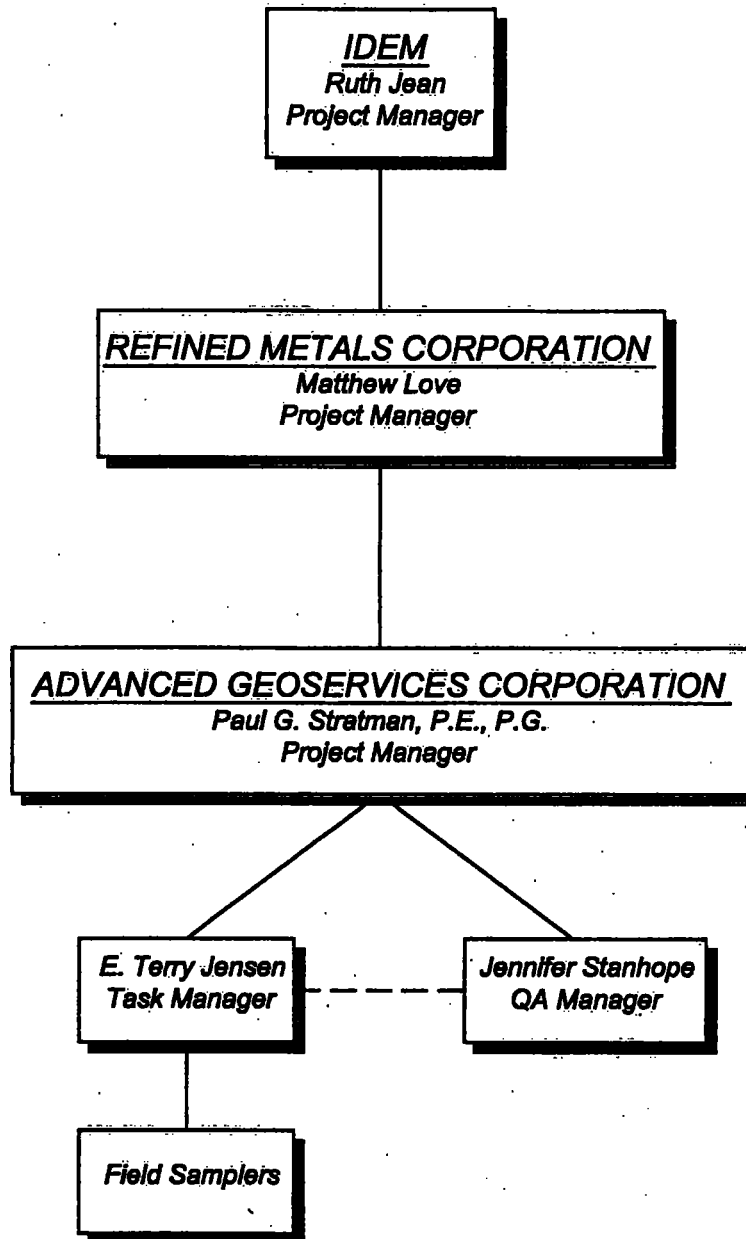
TABLE 11-1
REFINED METALS SITE
PREVENTATIVE MAINTENANCE PROCEDURES
SCHEDULE AND SPARE PARTS LIST

Instrument	Activity	Frequency	Spare Parts
ICP-MS	Change peristaltic tubing	Every 8 hours	Tubing
	Change gas and instrument filters	As needed	Filters
	Check to make sure the gas supply is sufficient for day's activities	Daily	Gases
	Clean nebulizer	Daily	
Hot plates	Monitor temperature	Daily	
Ovens	Monitor temperature	Daily	
Refrigerators	Monitor temperature	Daily	
pH meter	Calibrate with two standard solutions	Daily, throughout day	pH buffers
	Replace electrodes	As needed	Electrodes
Conductivity Meters	Calibrate	Daily	
	Check batteries	Daily	Batteries
Thermometer	Check against calibrated thermometer	Yearly	




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FIGURES



REFINED METALS CORPORATION
BEECH GROVE, INDIANA

Scale:	PROJECT ORGANIZATION CHART	
Originated By:		
Drawn By: P.G.S.		
Checked By: P.G.S.		
Project Mgr: P.G.S.		
Dwg. No. 2003-1046-05-01	 Advanced GeoServices Corp. 1055 Andrew Drive, Suite A West Chester, Pennsylvania 19380 (810) 840-9100 FAX: (610) 840-9199	
Issued By: AUG 06 2004	Project No. 2003-1046-05	FIGURE: 2-1



APPENDIX C

Statistical Evaluation of Surface Impoundment Wells

RMC Beechgrove
Statistical Comparisons of Groundwater Data
MW-6, MW-5 (downgradient) vs. MW-9 (upgradient)

Parameter	% detects	Distribution	Multiple Comparison	Significant Difference?	Paired Comparison	Significant Difference?
Arsenic	>50%	log normal	One-way ANOVA	no	t-test	no
Barium	>50%	normal	One-way ANOVA	yes	t-test	no
Chromium	<50%	normal	Kruskal-Wallis	no	Mann-Whitney	no
Lead	>50%	normal	One-way ANOVA	no	t-test	no
Cadmium	<50% (one hit)	normal	Kruskal-Wallis	no	Mann-Whitney	no
Selenium	<50% (one hit)	normal	Kruskal-Wallis	no	Mann-Whitney	no
Mercury	0%	upgradient and downgradient all non-detect...no statistics performed				
Antimony	0%	upgradient and downgradient all non-detect...no statistics performed				
Silver	0%	upgradient and downgradient all non-detect...no statistics performed				

one hit in 1991 (MW-5 = 1.1 µg/L), all other samples are non detect
one hit in 1999 (MW-5 = 2.9 µg/L), all other samples are non detect

LOC	DATE COLL	MATRIX	GROUP	T OR D	PARAMETER	UNITS	RESULT	QUAL	DL	% DETECTS
MW-5	6/12/1991	GW	M	T	ANTIMONY	MG/L		U	0.005	0%
MW-5	12/11/2001	GW	M	T	Antimony	ug/L	10	U	10	
MW-5	3/29/1993	GW	M	T	ANTIMONY	MG/L		U	0.005	
MW-5	12/14/1999	GW	M	T	Antimony	ug/L		U	10	
MW-5	9/22/1999	GW	M	T	ANTIMONY	UG/L		U	10	
MW-5	12/27/1996	GW	M	T	ANTIMONY	MG/L		U	0.005	
MW-5	10/26/2003	GW	M	T	Antimony	ug/L		U	10	
MW-5	12/4/1991	GW	M	T	ANTIMONY	MG/L		U	0.005	
MW-5	9/24/2001	GW	M	T	Antimony	ug/L		U	10	
MW-5	9/11/1991	GW	M	T	ANTIMONY	MG/L		U	0.005	
MW-5	6/13/1992	GW	M	T	ANTIMONY	MG/L		U	0.005	
MW-5	4/24/2005	GW	M	T	Antimony	ug/L		U	1	
MW-5	5/25/1993	GW	M	T	ANTIMONY	MG/L		U	0.005	
MW-5	9/30/1992	GW	M	T	ANTIMONY	MG/L		U	0.005	
MW-5	12/17/1992	GW	M	T	ANTIMONY	MG/L		U	0.005	
MW-5	7/30/1992	GW	M	T	ANTIMONY	MG/L		U	0.005	
MW-5	3/27/1992	GW	M	T	ANTIMONY	MG/L		U	0.005	
MW-6S	10/26/2003	GW	M	T	Antimony	ug/L		U	10	
MW-6S	12/11/2001	GW	M	T	Antimony	ug/L		U	10	
MW-6S	9/24/2001	GW	M	T	Antimony	ug/L		U	10	
MW-6SR	4/24/2005	GW	M	T	Antimony	ug/L		U	1	
MW-9	4/24/2005	GW	M	T	Antimony	ug/L		U	1	
MW-9	12/10/2001	GW	M	T	Antimony	ug/L		U	10	
MW-9	9/22/2001	GW	M	T	Antimony	ug/L		U	10	
MW-9	10/27/2003	GW	M	T	Antimony	ug/L		U	10	
MW-5	6/12/1991	GW	M	T	ARSENIC	MG/L		U	0.002	>50%
MW-5	12/14/1999	GW	M	T	Arsenic	ug/L	10		1	
MW-5	5/25/1993	GW	M	T	ARSENIC	MG/L		U	0.005	
MW-5	12/17/1992	GW	M	T	ARSENIC	MG/L	0.006		0.002	
MW-5	12/4/1991	GW	M	T	ARSENIC	MG/L		U	0.002	
MW-5	3/27/1992	GW	M	T	ARSENIC	MG/L	0.004		0.002	
MW-5	9/22/1999	GW	M	T	ARSENIC	UG/L	8.4		1	
MW-5	9/24/2001	GW	M	T	Arsenic	ug/L	7.6		1	
MW-5	6/13/1992	GW	M	T	ARSENIC	MG/L	0.057		0.002	
MW-5	12/27/1996	GW	M	T	ARSENIC	MG/L	0.0042		0.002	
MW-5	12/11/2001	GW	M	T	Arsenic	ug/L	5.4		1	
MW-5	3/29/1993	GW	M	T	ARSENIC	MG/L		U	0.005	
MW-5	9/30/1992	GW	M	T	ARSENIC	MG/L		U	0.002	
MW-5	7/30/1992	GW	M	T	ARSENIC	MG/L		U	0.002	
MW-5	9/11/1991	GW	M	T	ARSENIC	MG/L		U	0.002	
MW-5	4/24/2005	GW	M	T	Arsenic	ug/L	3.2		1	
MW-5	10/26/2003	GW	M	T	Arsenic	ug/L	8.8		1	
MW-6S	9/24/2001	GW	M	T	Arsenic	ug/L	1.9		1	
MW-6S	12/11/2001	GW	M	T	Arsenic	ug/L	2.2		1	
MW-6S	10/26/2003	GW	M	T	Arsenic	ug/L	7.6		1	
MW-6SR	4/24/2005	GW	M	T	Arsenic	ug/L	1.5		1	
MW-9	10/27/2003	GW	M	T	Arsenic	ug/L	4.2		1	
MW-9	9/22/2001	GW	M	T	Arsenic	ug/L	7.7		1	
MW-9	4/24/2005	GW	M	T	Arsenic	ug/L	2.1		1	
MW-9	12/10/2001	GW	M	T	Arsenic	ug/L	4		1	
MW-5	9/24/2001	GW	M	T	Barium	ug/L	170		10	>50%
MW-5	4/24/2005	GW	M	T	Barium	ug/L	177		10	
MW-5	10/26/2003	GW	M	T	Barium	ug/L	159		10	

MW-5	12/11/2001 GW	M	T	Barium	ug/L	150		10	
MW-5	9/22/1999 GW	M	T	BARIUM	UG/L	149		10	
MW-5	12/14/1999 GW	M	T	Barium	ug/L	162		10	
MW-6S	10/26/2003 GW	M	T	Barium	ug/L	228		10	
MW-6S	12/11/2001 GW	M	T	Barium	ug/L	79		10	
MW-6S	9/24/2001 GW	M	T	Barium	ug/L	92		10	
MW-6SR	4/24/2005 GW	M	T	Barium	ug/L	90		10	
MW-9	10/27/2003 GW	M	T	Barium	ug/L	43		10	
MW-9	4/24/2005 GW	M	T	Barium	ug/L	39		10	
MW-9	12/10/2001 GW	M	T	Barium	ug/L	68		10	
MW-9	9/22/2001 GW	M	T	Barium	ug/L	137		10	
MW-5	9/30/1992 GW	M	T	CADMIUM	MG/L		U	0.0002	<50%
MW-5	7/30/1992 GW	M	T	CADMIUM	MG/L		U	0.0002	
MW-5	9/24/2001 GW	M	T	Cadmium	ug/L		U	0.2	
MW-5	4/24/2005 GW	M	T	Cadmium	ug/L		U	0.2	
MW-5	6/13/1992 GW	M	T	CADMIUM	MG/L		U	0.0002	
MW-5	12/11/2001 GW	M	T	Cadmium	ug/L		U	0.2	
MW-5	6/12/1991 GW	M	T	CADMIUM	MG/L		U	0.0002	
MW-5	3/27/1992 GW	M	T	CADMIUM	MG/L		U	0.0002	
MW-5	12/14/1999 GW	M	T	Cadmium	ug/L		U	0.2	
MW-5	12/4/1991 GW	M	T	CADMIUM	MG/L		U	0.0002	
MW-5	5/25/1993 GW	M	T	CADMIUM	MG/L		U	0.001	
MW-5	12/27/1996 GW	M	T	CADMIUM	MG/L		U	0.001	
MW-5	10/26/2003 GW	M	T	Cadmium	ug/L		U	0.2	
MW-5	9/22/1999 GW	M	T	CADMIUM	UG/L		U	0.2	
MW-5	3/29/1993 GW	M	T	CADMIUM	MG/L		U	0.001	
MW-5	12/17/1992 GW	M	T	CADMIUM	MG/L		U	0.0002	
MW-6S	12/11/2001 GW	M	T	Cadmium	ug/L		U	0.2	
MW-6S	9/24/2001 GW	M	T	Cadmium	ug/L		U	0.2	
MW-6S	10/26/2003 GW	M	T	Cadmium	ug/L		U	0.2	
MW-6SR	4/24/2005 GW	M	T	Cadmium	ug/L		U	0.2	
MW-9	4/24/2005 GW	M	T	Cadmium	ug/L		U	0.2	
MW-9	10/27/2003 GW	M	T	Cadmium	ug/L		U	0.2	
MW-9	9/22/2001 GW	M	T	Cadmium	ug/L		U	0.2	
MW-9	12/10/2001 GW	M	T	Cadmium	ug/L		U	0.2	
MW-5	9/24/2001 GW	M	T	Chromium	ug/L		U	1	<50%
MW-5	12/14/1999 GW	M	T	Chromium	ug/L	1.9		1	
MW-5	12/11/2001 GW	M	T	Chromium	ug/L		U	1	
MW-5	9/22/1999 GW	M	T	CHROMIUM	UG/L	1.5	U	1	
MW-5	10/26/2003 GW	M	T	Chromium	ug/L	1.1		1	
MW-5	4/24/2005 GW	M	T	Chromium	ug/L		U	1	
MW-6S	12/11/2001 GW	M	T	Chromium	ug/L		U	1	
MW-6S	10/26/2003 GW	M	T	Chromium	ug/L	4.5		1	
MW-6S	9/24/2001 GW	M	T	Chromium	ug/L		U	1	
MW-6SR	4/24/2005 GW	M	T	Chromium	ug/L	1.3		1	
MW-9	12/10/2001 GW	M	T	Chromium	ug/L	2.2		1	
MW-9	9/22/2001 GW	M	T	Chromium	ug/L		U	1	
MW-9	10/27/2003 GW	M	T	Chromium	ug/L		U	1	
MW-9	4/24/2005 GW	M	T	Chromium	ug/L		U	1	
MW-5	9/22/1999 GW	M	T	LEAD	UG/L		U	1	>50%
MW-5	5/25/1993 GW	M	T	LEAD	MG/L		U	0.003	
MW-5	12/27/1996 GW	M	T	LEAD	MG/L	0.0093		0.002	

MW-5	3/29/1993	GW	M	T	LEAD	MG/L		U	0.005	
MW-5	12/11/2001	GW	M	T	Lead	ug/L	2.1		1	
MW-5	12/4/1991	GW	M	T	LEAD	MG/L		U	0.002	
MW-5	9/11/1991	GW	M	T	LEAD	MG/L		U	0.001	
MW-5	4/24/2005	GW	M	T	Lead	ug/L	9.1		1	
MW-5	7/30/1992	GW	M	T	LEAD	MG/L	0.014		0.002	
MW-5	9/24/2001	GW	M	T	Lead	ug/L	2		1	
MW-5	6/12/1991	GW	M	T	LEAD	MG/L	0.005		0.001	
MW-5	9/30/1992	GW	M	T	LEAD	MG/L	0.003		0.002	
MW-5	12/17/1992	GW	M	T	LEAD	MG/L		U	0.002	
MW-5	12/14/1999	GW	M	T	Lead	ug/L		UJ	1	
MW-5	6/13/1992	GW	M	T	LEAD	MG/L		U	0.002	
MW-5	3/27/1992	GW	M	T	LEAD	MG/L		U	0.002	
MW-5	10/26/2003	GW	M	T	Lead	ug/L	2.1		1	
MW-6S	10/26/2003	GW	M	T	Lead	ug/L	2.7		1	
MW-6S	9/24/2001	GW	M	T	Lead	ug/L		U	1	
MW-6S	12/11/2001	GW	M	T	Lead	ug/L	1.3		1	
MW-6SR	4/24/2005	GW	M	T	Lead	ug/L		U	1	
MW-9	4/24/2005	GW	M	T	Lead	ug/L	2.2		1	
MW-9	10/27/2003	GW	M	T	Lead	ug/L	1		1	
MW-9	9/22/2001	GW	M	T	Lead	ug/L	1.6		1	
MW-9	12/10/2001	GW	M	T	Lead	ug/L		U	1	
MW-5	4/24/2005	GW	M	T	Mercury	ug/L		U	0.2	0%
MW-5	9/24/2001	GW	M	T	Mercury	ug/L		U	0.2	
MW-5	12/14/1999	GW	M	T	Mercury	ug/L		U	0.2	
MW-5	12/11/2001	GW	M	T	Mercury	ug/L		U	0.2	
MW-5	9/22/1999	GW	M	T	MERCURY	UG/L		U	0.2	
MW-5	10/26/2003	GW	M	T	Mercury	ug/L		U	0.2	
MW-6S	10/26/2003	GW	M	T	Mercury	ug/L		U	0.2	
MW-6S	9/24/2001	GW	M	T	Mercury	ug/L		U	0.2	
MW-6S	12/11/2001	GW	M	T	Mercury	ug/L		U	0.2	
MW-6SR	4/24/2005	GW	M	T	Mercury	ug/L		U	0.2	
MW-9	10/27/2003	GW	M	T	Mercury	ug/L		U	0.2	
MW-9	12/10/2001	GW	M	T	Mercury	ug/L		U	0.2	
MW-9	9/22/2001	GW	M	T	Mercury	ug/L		U	0.2	
MW-9	4/24/2005	GW	M	T	Mercury	ug/L		U	0.2	
MW-5	12/11/2001	GW	M	T	Selenium	ug/L		U	2	<50%
MW-5	4/24/2005	GW	M	T	Selenium	ug/L		U	2	
MW-5	9/22/1999	GW	M	T	SELENIUM	UG/L		U	2	
MW-5	9/24/2001	GW	M	T	Selenium	ug/L		U	2	
MW-5	10/26/2003	GW	M	T	Selenium	ug/L		UJ	2	
MW-6S	9/24/2001	GW	M	T	Selenium	ug/L		U	2	
MW-6S	12/11/2001	GW	M	T	Selenium	ug/L		U	2	
MW-6S	10/26/2003	GW	M	T	Selenium	ug/L		UJ	2	
MW-6SR	4/24/2005	GW	M	T	Selenium	ug/L		U	2	
MW-9	9/22/2001	GW	M	T	Selenium	ug/L		U	2	
MW-9	4/24/2005	GW	M	T	Selenium	ug/L		U	2	
MW-9	12/10/2001	GW	M	T	Selenium	ug/L		U	2	
MW-9	10/27/2003	GW	M	T	Selenium	ug/L		UJ	2	
MW-5	12/11/2001	GW	M	T	Silver	ug/L		U	0.2	0%
MW-5	10/26/2003	GW	M	T	Silver	ug/L		U	0.2	
MW-5	9/24/2001	GW	M	T	Silver	ug/L		UJ	0.2	

MW-5	4/24/2005 GW	M	T	Silver	ug/L	UJ	0.2
MW-5	12/14/1999 GW	M	T	Silver	ug/L	UJ	0.2
MW-5	9/22/1999 GW	M	T	SILVER	UG/L	R	0.2
MW-6S	9/24/2001 GW	M	T	Silver	ug/L	UJ	0.2
MW-6S	12/11/2001 GW	M	T	Silver	ug/L	U	0.2
MW-6S	10/26/2003 GW	M	T	Silver	ug/L	U	0.2
MW-6SR	4/24/2005 GW	M	T	Silver	ug/L	UJ	0.2
MW-9	12/10/2001 GW	M	T	Silver	ug/L	U	0.2
MW-9	9/22/2001 GW	M	T	Silver	ug/L	UJ	0.2
MW-9	4/24/2005 GW	M	T	Silver	ug/L	UJ	0.2
MW-9	10/27/2003 GW	M	T	Silver	ug/L	U	0.2

LOCATION	DATE COLLECTED	PARAMETER	RESULT
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MW-5	6/12/1991	Arsenic	2
MW-5	9/11/1991	Arsenic	2
MW-5	12/4/1991	Arsenic	2
MW-5	3/27/1992	Arsenic	4
MW-5	6/13/1992	Arsenic	57
MW-5	7/30/1992	Arsenic	2
MW-5	9/30/1992	Arsenic	2
MW-5	12/17/1992	Arsenic	6
MW-5	3/29/1993	Arsenic	5
MW-5	5/25/1993	Arsenic	5
MW-5	12/27/1996	Arsenic	4.2
MW-5	9/22/1999	Arsenic	8.4
MW-5	12/14/1999	Arsenic	10
MW-5	9/24/2001	Arsenic	7.6
MW-5	12/11/2001	Arsenic	5.4
MW-5	10/26/2003	Arsenic	8.8
MW-5	4/24/2005	Arsenic	3.2
MW-6S	9/24/2001	Arsenic	1.9
MW-6S	12/11/2001	Arsenic	2.2
MW-6S	10/26/2003	Arsenic	7.6
MW-6S	4/24/2005	Arsenic	1.5
MW-9	9/22/2001	Arsenic	7.7
MW-9	12/10/2001	Arsenic	4
MW-9	10/27/2003	Arsenic	4.2
MW-9	4/24/2005	Arsenic	2.1

MW-5	9/22/1999	Barium	149
MW-5	12/14/1999	Barium	162
MW-5	9/24/2001	Barium	170
MW-5	12/11/2001	Barium	150
MW-5	10/26/2003	Barium	159
MW-5	4/24/2005	Barium	177
MW-6S	9/24/2001	Barium	92
MW-6S	12/11/2001	Barium	79
MW-6S	10/26/2003	Barium	228
MW-6S	4/24/2005	Barium	90
MW-9	9/22/2001	Barium	137
MW-9	12/10/2001	Barium	68
MW-9	10/27/2003	Barium	43
MW-9	4/24/2005	Barium	39

MW-5	6/12/1991	Cadmium	0.2
MW-5	9/11/1991	Cadmium	1.1
MW-5	12/4/1991	Cadmium	0.2
MW-5	3/27/1992	Cadmium	0.2
MW-5	6/13/1992	Cadmium	0.2
MW-5	7/30/1992	Cadmium	0.2
MW-5	9/30/1992	Cadmium	0.2
MW-5	12/17/1992	Cadmium	0.2

MW-5	3/29/1993	Cadmium	1
MW-5	5/25/1993	Cadmium	1
MW-5	12/27/1996	Cadmium	1
MW-5	9/22/1999	Cadmium	0.2
MW-5	12/14/1999	Cadmium	0.2
MW-5	9/24/2001	Cadmium	0.2
MW-5	12/11/2001	Cadmium	0.2
MW-5	10/26/2003	Cadmium	0.2
MW-5	4/24/2005	Cadmium	0.2
MW-6S	9/24/2001	Cadmium	0.2
MW-6S	12/11/2001	Cadmium	0.2
MW-6S	10/26/2003	Cadmium	0.2
MW-6S	4/24/2005	Cadmium	0.2
MW-9	9/22/2001	Cadmium	0.2
MW-9	12/10/2001	Cadmium	0.2
MW-9	10/27/2003	Cadmium	0.2
MW-9	4/24/2005	Cadmium	0.2

MW-5	9/22/1999	Chromium	1.5
MW-5	12/14/1999	Chromium	1.9
MW-5	9/24/2001	Chromium	1
MW-5	12/11/2001	Chromium	1
MW-5	10/26/2003	Chromium	1.1
MW-5	4/24/2005	Chromium	1
MW-6S	9/24/2001	Chromium	1
MW-6S	12/11/2001	Chromium	1
MW-6S	10/26/2003	Chromium	4.5
MW-6S	4/24/2005	Chromium	1.3
MW-9	9/22/2001	Chromium	1
MW-9	12/10/2001	Chromium	2.2
MW-9	10/27/2003	Chromium	1
MW-9	4/24/2005	Chromium	1

MW-5	6/12/1991	Lead	5
MW-5	9/11/1991	Lead	1
MW-5	12/4/1991	Lead	2
MW-5	3/27/1992	Lead	2
MW-5	6/13/1992	Lead	2
MW-5	7/30/1992	Lead	14
MW-5	9/30/1992	Lead	3
MW-5	12/17/1992	Lead	2
MW-5	3/29/1993	Lead	5
MW-5	5/25/1993	Lead	3
MW-5	12/27/1996	Lead	9.3
MW-5	9/22/1999	Lead	1
MW-5	12/14/1999	Lead	1
MW-5	9/24/2001	Lead	2
MW-5	12/11/2001	Lead	2.1
MW-5	10/26/2003	Lead	2.1
MW-5	4/24/2005	Lead	9.1

MW-6S	9/24/2001 Lead	1
MW-6S	12/11/2001 Lead	1.3
MW-6S	10/26/2003 Lead	2.7
MW-6S	4/24/2005 Lead	1
MW-9	9/22/2001 Lead	1.6
MW-9	12/10/2001 Lead	1
MW-9	10/27/2003 Lead	1
MW-9	4/24/2005 Lead	2.2

MW-5	9/22/1999 Selenium	2
MW-5	12/14/1999 Selenium	2.9
MW-5	9/24/2001 Selenium	2
MW-5	12/11/2001 Selenium	2
MW-5	10/26/2003 Selenium	2
MW-5	4/24/2005 Selenium	2
MW-6S	9/24/2001 Selenium	2
MW-6S	12/11/2001 Selenium	2
MW-6S	10/26/2003 Selenium	2
MW-6S	4/24/2005 Selenium	2
MW-9	9/22/2001 Selenium	2
MW-9	12/10/2001 Selenium	2
MW-9	10/27/2003 Selenium	2
MW-9	4/24/2005 Selenium	2

Arsenic

MW-9

All_Down

Sample size (N)	4	21
Num missings	0	0
Minimum	2.1000	1.5000
Maximum	7.7000	57.0000
Std deviation	2.3338	11.7517
Variance	5.4467	138.1015
Std error	1.1669	2.5644
C.V.	51.8624	166.9721
Mean	4.5000	7.0381
Geometric mean	4.0598	4.3117
Quadratic mean	4.9331	13.4559
Harmonic mean	3.6558	3.3263
Median	4.1000	4.2000
Kurtosis	2.0178	18.5792
Coeff kurtosis	5.0178	21.5792
Skewness	0.9856	4.2074
Coeff skewness	0.4928	2.1037
Quartiles:		
First quartile:	3.5250	2.0000
Second quartile:	4.1000	4.2000
Third quartile:	5.0750	7.6000

Log Normal descriptive statistics

all_down_log

Sample size (N)	21
Num missings	0
Minimum	0.4055
Maximum	4.0431
Std deviation	0.8502
Variance	0.7229
Std error	0.1855
C.V.	58.1820
Mean	1.4613
Geometric mean	1.2483
Quadratic mean	1.6805
Harmonic mean	1.0619
Median	1.4351
Kurtosis	2.8573
Coeff kurtosis	5.8573
Skewness	1.3087
Coeff skewness	0.6544
Quartiles:	
First quartile:	0.6931
Second quartile:	1.4351
Third quartile:	2.0281

Data Distribution is Normal for Upgradient (MW-9), and Log Normal for downgradient (MW-5 and MW-6)

Arsenic (continued)

One Way ANOVA

ColName	Count	Mean	Std.Dev.	Std.Err.
mw-9_log	4	1.4011	0.5309	0.2655
all_down_log	21	1.4613	0.8502	0.1855

One-Way ANOVA Results

Source	DF	SS	MS	F	P
Between Groups	1	0.0122	0.0122	0.0183	
Within Groups	23	15.3035	0.6654		
Total	24	15.3157			

Confidence Level = 99.00%
Critical F(0.0100,1,23) = 7.8811

t-test

Confidence Level = 0.99 [Two Tail Test]

mw-5_log vs. mw-9_log:

	mw-5_log	mw-9_log	
Sample Size	17	4	
Number of Missings	0	0	
Mean	1.5779	1.4011	Difference =
	0.1768		
Variance	0.7292	0.2819	Ratio =
	2.5868		

	t-Value	Probability	DF	Critical t-Value
Paired	-1.2722		3	5.8409
Co-Variance = -0.1523		Std Deviation = 0.4203		

mw-6s_log vs. mw-9_log:

	mw-6s_log	mw-9_log	
Sample Size	4	4	
Number of Missings	0	0	
Mean	0.9660	1.4011	Difference = -
	0.4352		
Variance	0.5263	0.2819	Ratio =
	1.8672		

	t-Value	Probability	DF	Critical t-Value
Paired	-1.0598		3	5.8409
Co-Variance = 0.0669		Std Deviation = 0.4106		

Barium

	MW-9	all_down
Sample size (N)	4	10
Num missings	0	0
Minimum	39.0000	79.0000
Maximum	137.0000	228.0000
Std deviation	45.3532	46.2486
Variance	2056.9167	2138.9333
Std error	22.6766	14.6251
C.V.	63.2101	31.7642
Mean	71.7500	145.6000
Geometric mean	62.8696	138.4269
Quadratic mean	81.7970	152.0671
Harmonic mean	56.4159	130.8949
Median	55.5000	154.5000
Kurtosis	2.2260	-0.2835
Coeff kurtosis	5.2260	2.7165
Skewness	1.5641	-0.0132
Coeff skewness	0.7820	-0.0066
Quartiles:		
First quartile:	42.0000	106.2500
Second quartile:	55.5000	154.5000
Third quartile:	85.2500	168.0000

Data Distribution is Normal

One-way ANOVA

ColName	Count	Mean	Std.Dev.	Std.Err.
MW-9	4	71.7500	45.3532	22.6766
all_down	10	145.6000	46.2486	14.6251

One-Way ANOVA Results

Source	DF	SS	MS	F	P
Between Groups	1	15582.3500	15582.3500	7.3556	
Within Groups	12	25421.1500	2118.4292		
Total	13	41003.5000			

Confidence Level = 99.00%
Critical F(0.0100,1,12) = 9.3302

Barium (continued)

t-test

Confidence Level = 0.99 [Two Tail Test]

MW-5 vs. MW-9:

	MW-5	MW-9	
Sample Size	6	4	
Number of Missings	0	0	
Mean	161.1667	71.7500	Difference =
89.4167			
Variance	121.3667	2056.9167	Ratio =
0.0590			

	t-Value	Probability	DF	Critical t-Value
Paired	3.3633		3	5.8409
	Co-Variance = -228.4167 , Std Deviation = 25.5702			

MW-6S vs. MW-9:

	MW-6S	MW-9	
Sample Size	4	4	
Number of Missings	0	0	
Mean	122.2500	71.7500	Difference =
50.5000			
Variance	5002.9167	2056.9167	Ratio =
2.4322			

	t-Value	Probability	DF	Critical t-Value
Paired	1.0313		3	5.8409
	Co-Variance = -1265.2500 , Std Deviation = 48.9651			

Cadmium

	MW-9	all_down
Sample size (N)	4	21
Num missings	0	0
Minimum	0.2000	0.2000
Maximum	0.2000	1.1000
Std deviation	0.0000	0.3325
Variance	0.0000	0.1106
Std error	0.0000	0.0726
C.V.	0.0000	93.1064
Mean	0.2000	0.3571
Geometric mean	0.2000	0.2730
Quadratic mean	0.2000	0.4826
Harmonic mean	0.2000	0.2362
Median	0.2000	0.2000
Kurtosis	NaN	1.0615
Coeff kurtosis	NaN	4.0615
Skewness	NaN	1.7149
Coeff skewness	NaN	0.8575
Quartiles:		
First quartile:	0.2000	0.2000
Second quartile:	0.2000	0.2000
Third quartile:	0.2000	0.2000

Data Distribution is Normal

Kruskal-Wallis test (<50% detects)

Ranked Data Statistics Table

Column Name	Count	Ranked Sum	Average Rank
MW-9	4	44.0000	11.0000
all_down	21	281.0000	13.3810

Column Name	Mean	Std.Dev.	Median	25 - 75
MW-9	0.2000	0.0000	0.2000	0.2000
all_down	0.3571	0.3325	0.2000	0.2000

H (test value) = 0.351648
Degree of Freedom = 1
Probability =

Cadmium (continued)

Mann-Whitney test

MW-5 vs. MW-9:

Column Name	MW-5	MW-9
Sample Size	17	4
Total Sum	6.7000	0.8000
Mean	0.3941	0.2000

Minimum Sample Size = 4
U1 = 42.000000
R1 = 36.000000
Maximum Sample Size = 17
U2 = 26.000000
R2 = 195.000000
Minimum U = 26.000000
Standard Deviation = 11.165423
z-score = 0.716498
Two-tailed P value = [REDACTED]

MW-6S vs. MW-9:

Column Name	MW-6S	MW-9
Sample Size	4	4
Total Sum	0.8000	0.8000
Mean	0.2000	0.2000

Minimum Sample Size = 4
U1 = 8.000000
R1 = 18.000000
Maximum Sample Size = 4
U2 = 8.000000
R2 = 18.000000
Minimum U = 8.000000
Standard Deviation = 3.464102
z-score = 0.000000
Two-tailed P value = [REDACTED]

[REDACTED]

Chromium

MW-9

all_down

Sample size (N)	4	10
Num missings	0	0
Minimum	1.0000	1.0000
Maximum	2.2000	4.5000
Std deviation	0.6000	1.0853
Variance	0.3600	1.1779
Std error	0.3000	0.3432
C.V.	46.1538	70.9350
Mean	1.3000	1.5300
Geometric mean	1.2179	1.3376
Quadratic mean	1.4000	1.8442
Harmonic mean	1.1579	1.2356
Median	1.0000	1.0500
Kurtosis	4.0000	7.9715
Coeff kurtosis	7.0000	10.9715
Skewness	2.0000	2.7610
Coeff skewness	1.0000	1.3805
Quartiles:		
First quartile:	1.0000	1.0000
Second quartile:	1.0000	1.0500
Third quartile:	1.3000	1.4500

Data Distribution is Normal

Kruskal-Wallis test (<50% detects)

Ranked Data Statistics Table

Column Name	Count	Ranked Sum	Average Rank
MW-9	4	26.5000	6.6250
all_down	10	78.5000	7.8500

Column Name	Mean	Std.Dev.	Median	25 - 75
MW-9	1.3000	0.6000	1.0000	1.0000
all_down	1.5300	1.0853	1.0500	1.0000

H (test value) = 0.245000
Degree of Freedom = 1
Probability =

Chromium (continued)

Mann-Whitney test

MW-5 vs. MW-9:

Column Name	MW-5	MW-9
Sample Size	6	4
Total Sum	7.5000	5.2000
Mean	1.2500	1.3000
Minimum Sample Size =	4	
U1 =	13.500000	
R1 =	20.500000	
Maximum Sample Size =	6	
U2 =	10.500000	
R2 =	34.500000	
Minimum U =	10.500000	
Standard Deviation =	4.690416	
z-score =	0.319801	
Two-tailed P value =		

MW-6S vs. MW-9:

Column Name	MW-6S	MW-9
Sample Size	4	4
Total Sum	7.8000	5.2000
Mean	1.9500	1.3000
Minimum Sample Size =	4	
U1 =	6.000000	
R1 =	20.000000	
Maximum Sample Size =	4	
U2 =	10.000000	
R2 =	16.000000	
Minimum U =	6.000000	
Standard Deviation =	3.464102	
z-score =	0.577350	
Two-tailed P value =		

Lead

	MW-9	all_down
Sample size (N)	4	21
Num missings	0	0
Minimum	1.0000	1.0000
Maximum	2.2000	14.0000
Std deviation	0.5745	3.4057
Variance	0.3300	11.5989
Std error	0.2872	0.7432
C.V.	39.6177	99.8883
Mean	1.4500	3.4095
Geometric mean	1.3697	2.4361
Quadratic mean	1.5330	4.7615
Harmonic mean	1.2989	1.9182
Median	1.3000	2.0000
Kurtosis	-1.2893	4.0517
Coeff kurtosis	1.7107	7.0517
Skewness	0.8546	2.0791
Coeff skewness	0.4273	1.0396
Quartiles:		
First quartile:	1.0000	1.1500
Second quartile:	1.3000	2.0000
Third quartile:	1.7500	4.0000

Data Distribution is Normal

One-way ANOVA

ColName	Count	Mean	Std.Dev.	Std.Err.
MW-9	4	1.4500	0.5745	0.2872
all_down	21	3.4095	3.4057	0.7432

One-Way ANOVA Results

Source	DF	SS	MS	F	P
Between Groups	1	12.9015	12.9015	1.2737	
Within Groups	23	232.9681	10.1290		
Total	24	245.8696			

Confidence Level = 99.00%
Critical F(0.0100,1,23) = 7.8811

Lead (continued)

t-test

Confidence Level = 0.99 [Two Tail Test]

MW-5 vs. MW-9:

		MW-5	MW-9	
	Sample Size	17	4	
	Number of Missings	0	0	
	Mean	3.8588	1.4500	Difference =
2.4088				
	Variance	13.2488	0.3300	Ratio =
40.1480				
	t-Value	Probability	DF	Critical t-Value
Paired	1.2710		3	5.8409
	Co-Variance = 0.3000			Std Deviation = 0.8261

MW-6S vs. MW-9:

		MW-6S	MW-9	
	Sample Size	4	4	
	Number of Missings	0	0	
	Mean	1.5000	1.4500	Difference =
0.0500				
	Variance	0.6600	0.3300	Ratio =
2.0000				
	t-Value	Probability	DF	Critical t-Value
Paired	0.0793		3	5.8409
	Co-Variance = -0.3000			Std Deviation = 0.6305

[REDACTED]

Selenium

	MW-9	all_down
Sample size (N)	4	10
Num missings	0	0
Minimum	2.0000	2.0000
Maximum	2.0000	2.9000
Std deviation	0.0000	0.2846
Variance	0.0000	0.0810
Std error	0.0000	0.0900
C.V.	0.0000	13.6175
Mean	2.0000	2.0900
Geometric mean	2.0000	2.0757
Quadratic mean	2.0000	2.1074
Harmonic mean	2.0000	2.0641
Median	2.0000	2.0000
Kurtosis	NaN	10.0000
Coeff kurtosis	NaN	13.0000
Skewness	NaN	3.1623
Coeff skewness	NaN	1.5811
Quartiles:		
First quartile:	2.0000	2.0000
Second quartile:	2.0000	2.0000
Third quartile:	2.0000	2.0000

Data Distribution is Normal

Kruskal-Wallis test (<50% detects)

Ranked Data Statistics Table

Column Name	Count	Ranked Sum	Average Rank
MW-9	4	28.0000	7.0000
all_down	10	77.0000	7.7000

Column Name	Mean	Std.Dev.	Median	25 - 75
MW-9	2.0000	0.0000	2.0000	2.0000
all_down	2.0900	0.2846	2.0000	2.0000

H (test value) = 0.080000
Degree of Freedom = 1
Probability = 0.7710



Selenium (continued)

Mann-Whitney test

MW-5 vs. MW-9:

Column Name	MW-5	MW-9
Sample Size	6	4
Total Sum	12.9000	8.0000
Mean	2.1500	2.0000
Minimum Sample Size = 4		
U1 = 14.000000		
R1 = 20.000000		
Maximum Sample Size = 6		
U2 = 10.000000		
R2 = 35.000000		
Minimum U = 10.000000		
Standard Deviation = 4.690416		
z-score = 0.426401		
Two-tailed P value =		

MW-6S vs. MW-9:

Column Name	MW-6S	MW-9
Sample Size	4	4
Total Sum	8.0000	8.0000
Mean	2.0000	2.0000
Minimum Sample Size = 4		
U1 = 8.000000		
R1 = 18.000000		
Maximum Sample Size = 4		
U2 = 8.000000		
R2 = 18.000000		
Minimum U = 8.000000		
Standard Deviation = 3.464102		
z-score = 0.000000		
Two-tailed P value =		



**SAMPLING AND ANALYSIS PLAN
FOR
GROUNDWATER MONITORING**

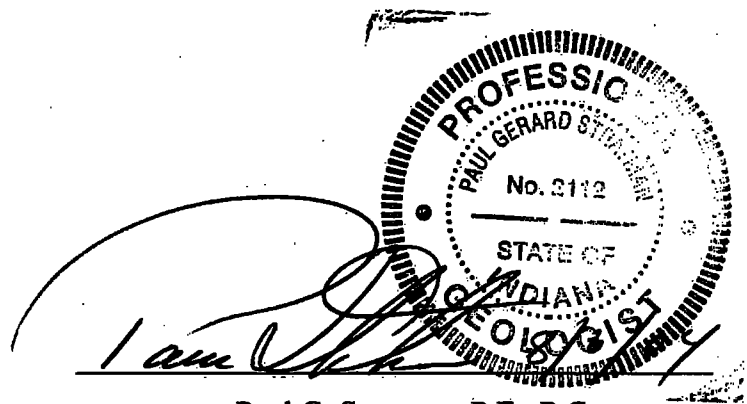
Prepared for:
REFINED METALS CORPORATION
Beech Grove, Indiana

Prepared by:
ADVANCED GEOSERVICES CORP.
West Chester, Pennsylvania

Project No. 2003-1046-00
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GROUNDWATER MONITORING PLAN



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Indiana PG 2112
Indiana PE 19400366



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1.0 INTRODUCTION

On July 14, 1998, Refined Metals Corporation (RMC) entered into a Consent Decree with the Indiana Department of Environmental Management (IDEM) and the United States Environmental Protection Agency (EPA) to settle complaints against RMC by IDEM and EPA regarding certain environmental matters at the RMC Facility located at 3700 Arlington Avenue, Beech Grove, Indiana (the "Site"). Section VI, Paragraph 37 of the Consent Decree requires that RMC close the onsite surface impoundment in accordance with the requirements of 40 C.F.R. Part 265, Subparts F and G, and 329 IAC 3.1-10-1(8). Among other things, these regulations require that, for the surface impoundment, a groundwater monitoring program must be in place to determine the surface impoundment's impact to groundwater. This Sampling and Analysis Plan (SAP) for Groundwater Monitoring specifies how groundwater will be monitored to meet this requirement.



2.0 SITE HISTORY

2.1 GENERAL SITE DESCRIPTION

The Site was the location of secondary lead smelting operations from 1968 through 1995. The location of the Site is shown on Figure 2-1. The Site ceased normal operations on December 31, 1995. The Site, as shown on Figure 2-2, covers approximately 24 acres which includes approximately 10 acres where smelting operations occurred. The remainder of the Site consists of areas of lawn and woods. The former smelter area contains several structures identified as the Battery Breaker, Material Storage and Furnace, Refining, Waste Water Treatment/Filter Press, and Office Buildings. Other smaller structures exist including a vehicle maintenance building, baghouses, and pump houses.

At this time, the Site is idle except for the storm water treatment system, which remains in operation to collect and treat storm water runoff from the lined lagoon and other site areas. The indoor and outdoor waste piles have been removed.

2.2 OPERATIONAL HISTORY

2.2.1 Operations

During its operating life, the facility handled materials, which were classified as hazardous materials or hazardous wastes under the Resource Conservation and Recovery Act (RCRA). These primarily consisted of lead bearing materials that were processed for lead recovery. In accordance with the requirements of RCRA, the facility completed and submitted a RCRA permit application. On November 19, 1980 the facility was granted approval to operate indoor and outdoor hazardous waste piles under Interim Status. Facility documents also identify a lined lagoon; however, it does not appear to have been included on the Facility Part A Permit Application until after 1991. The lagoon was, and still is used, to collect facility storm water runoff.



2.2.2 Smelting

The facility was constructed as a secondary lead smelter to recycle lead-acid batteries and other lead bearing wastes. Auto batteries constituted 90 percent of the materials recycled, and the remainder was waste material from battery manufacturers and other lead scrap. Prior to 1984, battery crushing was performed off-site at other commercial facilities. In 1984, the battery breaker was constructed on-site. The batteries were fed into the battery crusher where the tops of the batteries were sawed off and the sulfuric acid was collected in a sump and transferred into a stainless steel tank that drained to the wastewater treatment system. The battery casings and their contents were tumbled and crushed. Lead plates and other lead parts were separated and transported to waste piles to be later fed into the furnace. The battery casings were shredded and separated into plastic and ebonite in a flotation tank. The plastic was blown into a trailer for sale to an offsite recycler. Ebonite casings were placed in a separate waste pile and then fed into the blast furnace as a supplemental fuel.

2.2.3 Refining

Molten lead from the blast furnace was tapped from the bottom of the furnace to kettles in the adjacent refining and casting area. In the kettles, the molten lead was tested to determine its quality. Antimony and tin were either added or removed to create the required lead type and quality. Removal of antimony and tin was performed by adding sodium hydroxide or through oxidation. If the lead contained excess copper it was removed through the addition of red phosphorus. The excess antimony, tin, copper, and other impurities formed as dross on top of the molten lead and were removed through skimming. The dross was returned to the blast furnace. The refined lead was typically cast into 60-pound bars that were cooled, extracted and stacked for shipment off-site.



3.0 SITE SETTING

3.1 PHYSICAL SETTING

The Site is located in the White River Drainage Basin. The Site is situated on a minor local topographic high with a surface elevation of approximately 845 feet above mean sea level (msl). The surface elevation slopes gently to the southeast toward Sloan Ditch, and the northwestern perimeter of the Site slopes to the northwest toward the intermittent headwaters of Beech Creek. Surface water from within the former manufacturing areas of the Site is collected in the storm water management basin and is treated and discharged to the municipal sewer system.

Prior to construction of the present-day storm water collection and control system, surface water from the northern portion of the facility flowed to the intermittent stream that flows northwest to the headwaters of Beech Creek. Surface water from other areas on the Site historically flowed to the same location as the present-day (geomembrane lined) storm water basin, which was reportedly concrete lined. Water collected in this impoundment either evaporated, or when full, overflowed to a drainage ditch that flowed off-site to the east and then to the south, eventually discharging to Sloan Ditch. Sloan Ditch flows 0.6 mile west-southwest to Churchman Creek, which flows to the west 0.9 mile and discharges to Beech Creek. Beech Creek flows 1.2 miles to the southwest to Lick Creek, which then flows 7 miles to the White River.

3.2 REGIONAL GEOLOGY AND HYDROGEOLOGY

The surficial geology of Marion County is glacial till (Tipton Till Plain) consisting of yellowish-gray, bluish-gray, or gray sand or silt with some clay and pebbles and scattered cobbles and boulders. The drift cover in Marion County is believed to be composed of three drift sheets resulting from the Kansan, Illinoian, and Wisconsin glaciations. Till thicknesses range from less than 15 feet to greater than 400 feet. The Site is underlain by approximately 200 feet of unconsolidated material. Bedrock is encountered at an elevation of approximately 640 feet mean sea level (on the order of 200 feet bgs), and consists of middle Devonian-aged dolomitic limestones. The limestones consist primarily



of the Geneva Dolomite and the Jefferson Limestone. The Geneva Dolomite is a light gray to tan and buff to chocolate brown dolomite that contains white crystalline calcite masses. The Jeffersonville Limestone is a pure limestone in the upper portion of the formation, and is laminated with organic material in the lower portion. The organic laminae are more argillaceous than the coralline zone (Harrison, 1963). Meyer, 1975 indicates that shale is present beneath the glacial till and overlying the limestones. Additional detail on the shale unit is not provided by Meyer. The regional dip is to the southwest so that progressively younger formations are encountered below the till plain to the southwest.

Regionally, groundwater is encountered in un-named sand and gravel beds overlying the bedrock, the Jefferson Limestone and Geneva Dolomite, and the Niagaran Limestones (Harrison, 1963). The sand and gravel glacial outwash that coincides with the courses of the White River and Fall Creek is the aquifer of greatest economic importance in Marion County. The location of this aquifer generally coincides with the glacial melt water and outwash deposits along the major streams. Fall Creek enters White River upstream of the Site. The White River sand and gravel aquifer is located approximately 5.3 miles west of the Site. The sand and gravel aquifer is unconfined and flows toward and discharges to the surface water bodies. The hydraulic conductivity was determined for sand, sand and gravel, and gravel by Meyer, 1975 and is as follows:

Sand	40 ft/day
Sand and Gravel	240 ft/day
Gravel	415 ft/day

The hydraulic conductivity of the silt and clay was determined to be too low for reporting purposes by Meyer. Specific capacity and lithologic information used in Meyer's hydraulic conductivity calculations of the sand and gravel glacial outwash deposits were obtained from drillers' records. It is noted by Meyer that three thin, areally discontinuous, sheet-like deposits of sand and gravel in the till-plain area are separated by beds of silt and clay that cause the groundwater in these deposits to be semi-confined. Meyer also notes that large areas of silt and clay often separate one area of an



borings were advanced to a final depth of 130 feet bgs, as specified in the Phase I RFI Work Plan. The regional uppermost semi-confined aquifer was not encountered in any of the deep borings.



4.0 SUMMARY OF PREVIOUS GROUNDWATER SAMPLING

4.1 GENERAL

Two groundwater sampling events were performed as part of the Phase I RFI. The wells sampled during the Phase I RFI included five original wells, MW-1 through 5, screened in the shallow perched zone, one shallow well, MW-6, and two deeper wells screened in the middle perched zone, MW-2D and MW-6D.

Two additional rounds of groundwater sampling were performed during Phase II RFI investigation activities which also included the installation of three additional shallow wells, MW-7, 8, and 9. A fifth groundwater sampling event was performed during October 2003, which also included the installation of two more shallow wells, MW-10 and 11. The sampling results are provided in Tables 4-1 through 4-14.

4.2 SUMMARY OF GROUNDWATER SAMPLING RESULTS

This summary of groundwater sampling results includes all of the analytical results for groundwater samples collected during the RFI. As shown, this includes the results of up to five sampling events. The results may be summarized as follows:

Antimony

Antimony analysis was performed on 22 filtered and 41 unfiltered samples from wells monitoring the shallow perched groundwater zone. The method detection limit for all analysis was 10 µg/l. Antimony was detected in one unfiltered sample at a concentration of 14 µg/l. That sample was the first sample collected from MW-8 (9/22/01) following well installation. All other samples (filtered and unfiltered) were below detection. The Region IX Preliminary Remediation Goal (PRG) for tap water is 15 µg/l. The IDEM default value for residential groundwater is 6 µg/l.



Four unfiltered samples were collected and analyzed for antimony from the wells monitoring the middle perched zone (MW-2D and MW-6D). All four results were below the detection limits of 10 ug/l.

Arsenic

Arsenic analysis was performed on 22 filtered and 41 unfiltered samples from wells monitoring the shallow perched groundwater zone. The method detection limit for all analysis was 1.0 µg/l. Arsenic was detected in nearly every sample analyzed, including the well designated as the upgradient well (MW-9.) The Region IX Preliminary Remediation Goal (PRG) for arsenic in tap water is 0.045µg/l. The IDEM default value for arsenic in residential groundwater is 50 µg/l. A background concentration for arsenic calculated as the mean plus one standard deviation using the unfiltered results from MW-9 was 8.5 µg/l. When compared against the IDEM residential default value of 50 µg/l one sample (MW-7, October 2003) had an exceedance. When compared against the calculated background value of 8.5 µg/l, 23 of 41 unfiltered samples and 8 of the 22 filtered samples represented an exceedance. Sixteen (16) unfiltered samples and all 8 of the filtered samples exceeding 8.5 µg/l were collected from wells MW-1, MW-2, MW-7, MW-8, and MW-10.

Four unfiltered samples were collected and analyzed for arsenic from the wells monitoring the middle perched zone (MW-2D and MW-6D). None of the results exceeded the IDEM residential default value of 50 µg/l. No regional background concentration for arsenic has been established for the middle perched zone.



Lead

Lead analysis was performed on 22 filtered and 41 unfiltered samples from wells monitoring the shallow perched groundwater zone. The method detection limit for lead analysis was 1.0 µg/l. Lead was detected in 25 of the 41 unfiltered samples and 6 of the 22 filtered samples. The IDEM default value for lead in residential groundwater is 15 µg/l. USEPA Region IX does not list a PRG for lead in tap water. Eleven (11) of the unfiltered samples and five of the filtered had lead concentrations equal to or greater than 15 µg/l. Ten (10) of the unfiltered and all of the filtered results equal to or greater than 15 µg/l came from MW-2, MW-7, and MW-8. The remaining single unfiltered exceedance was collected during the first round of sampling from MW-6 using a baler, while all other wells were sampled using low flow sampling techniques. MW-6 was reconstructed during August 2001 and subsequent sampling events were completed using low flow sampling techniques. No exceedances were observed in MW-6 after reconstruction.

Four unfiltered samples were collected and analyzed for lead from the wells monitoring the middle perched zone (MW-2D and MW-6D). Groundwater sampling results for the middle perched zone indicated a total lead concentration below the EPA Action Level of 15 µg/l in the samples collected during the Phase I RFI.

Other Metals

Other metals analyzed during the RFI groundwater sampling were cadmium, barium, chromium, mercury, selenium, and silver. No exceedances of the corresponding values under the IDEM default residential or Region IX tap water PRGs were observed for these compounds in either the shallow or middle perched zones.



5.0 SAMPLING RATIONALE

Under this plan, RMC proposes to collect and analyze samples from four (4) shallow groundwater monitoring wells. The groundwater monitoring wells to be sampled will be existing wells MW-9, MW-6SR and MW-5, and proposed well MW-12. Groundwater monitoring well MW-9 will function as the upgradient well for the monitoring. Groundwater monitoring wells MW-6SR, 5 and 12 will be considered downgradient. Groundwater monitoring well MW-12 will be located at the toe of slope along the south side of the lagoon west of groundwater monitoring well MW-6SR. Groundwater monitoring well MW-5 is being retained as a downgradient well because of its proximity to the lagoon and because the susceptibility of MW-5 to seasonal fluctuations in the perched groundwater zone is not known. Synoptic water levels will be collected during each sampling event from all Site groundwater monitoring wells (MW-1, MW-2, MW-2D, MW-3, MW-4, MW-5, MW-6D, MW-6SR, MW-7, MW-8, MW-9, MW-10, MW-11 and MW-12) at the Site.

The four selected groundwater monitoring wells will be sampled once per calendar quarter (i.e., January through March, April through June, July through September, and October through December) during the first year and semi-annually (approximately once every six months) thereafter, until completion of closure activities. Samples will be submitted to Tri-Matrix Laboratories (Grand Rapids, Michigan) and analyzed for antimony, arsenic, and lead (these are the only compounds encountered during previous sampling events at or above the IDEM residential groundwater default value or the USEPA Region IX PRG). In addition, the analysis of water quality parameters as defined under 40 CFR 265.92 will include chloride, iron, sodium and sulfate. Total organic carbon (TOC) and total organic halogen (TOH) will not be analyzed as part of the water quality analysis. A detailed evaluation of VOCs potentially used at the facility in the past was performed as part of the RFI. This evaluation include review of hazardous waste manifest reports, Form R reports, Tier II reports, RCRA inspection reports, RCRA permit applications, environmental risk assessments, and employee interviews. Based on this evaluation, Exide and EPA agreed to a limited number of VOCs that might be present based on historic operations. These VOCs included 1,1,1-trichloroethane, tetrachlorethene, benzene, toluene, and ethylbenzene. During the RFI, all monitoring wells were



sampled for these VOCs and none were detected. Therefore, analysis for any VOCs is not warranted. Sampling equipment and method procedures are present in Section 6.0 and in Appendix B. Sample analysis methods are present in Section 7.0 and the QAPP. All sampling methods and analysis will be performed in accordance with the protocol and quality assurance procedures described in the the QAPP. Analysis will include filtered and unfiltered samples to allow clarification and understanding of contribution by suspended solids (un-filtered results minus filtered results) versus actual water quality (filtered results).

Analytical data packages will be reviewed and validated by an AGC data validator as described in the QAPP. Following validation, the results will be submitted to the IDEM both in a paper and electronic format. The results will include a groundwater contour map for depth to water measurements taken at the time of sampling, a table of results specific to the sampling event, and a summary table on a well by well basis.

As part of this SAP the results will be reviewed for indicators of possible releases of hazardous constituents to the groundwater. The results of each sampling event will be evaluated and compared to past sampling historical results for each selected groundwater monitoring well and variations at the upgradient groundwater monitoring well. Comparisons of upgradient and downgradient results will be performed using Student's t-test at the 0.01 level of significance over initial background following the preparation of the groundwater contour map(s) and the summarization of analytical result data. The extent and rate of migration will be estimated if a release of a hazardous constituent is indicated. All results (regardless of what they indicate) will be reported to IDEM. If results of unit "monitoring" indicate a release, then a site wide assessment would be performed under EPA RFI/CA.



6.0 SAMPLING EQUIPMENT AND PROCEDURES

6.1 SAMPLING EQUIPMENT

The following section outlines the sampling equipment required for the groundwater sampling at the Site.

6.1.1 Groundwater Sampling Equipment

The following equipment will be used for the groundwater monitoring wells sampling:

- Low-flow bladder pump and control box;
- Flow through cell;
- Generator and/or nitrogen tank;
- Laboratory supplied containers for the collection of metals samples;
- Ice cooler for sample storage and transport;
- Ice;
- pH/temperature meter;
- Conductivity meter;
- Depth to water meter;
- Interface probe;
- Teflon[®] tubing; and,
- Disposable bailers.

6.2 GROUNDWATER SAMPLING PROCEDURES

The following sections describe groundwater sampling procedures. The groundwater monitoring well sampling is comprised of synoptic water level measurements, field analysis, well purge techniques, sample collection, and decontamination procedures as described in more detail below.



Groundwater sampling will begin at MW-9, the designated up-gradient monitoring well, then proceed to the next selected well with the lowest historical total metal concentration.

6.2.1 Synoptic Water Levels

Prior to all groundwater sampling events, depth-to-water will be measured in each well (MW-1, MW-2, MW-2D, MW-3, MW-4, MW-5, MW-6, MW-6SR, MW-7, MW-8, MW-9, MW-10, MW-11 and MW-12) using an electronic water level indicator. The synoptic measurements will include the measurement of water levels and well depths in the monitoring wells in as short a time frame as possible to determine the piezometric surface across the Site. The field personnel will measure the water levels in the wells to the nearest 0.01 foot using the surveyed point at the top of the inner well casing for reference. Measurements will be repeated at each well until two consecutive readings are within 0.01 feet. Total depths will also be measured in each well after (to avoid suspension of sealed solis) each sampling event to evaluate whether any silting of the well has occurred between sampling rounds. Water levels measurements will be collected following IDEM Guidance Documents titled for Collecting Static Water Level Measurements and Developing Ground Water Flow Maps.

6.2.2 Field Analyses

Field measurements that will be performed during well purging will include pH, specific conductivity, temperature, oxidation/reduction potential (ORP), dissolved oxygen (DO), and turbidity. Measurements will be collected by inserting the appropriate probe in a closed non-dedicated plastic container (flow-through-cell) that is rinsed with deionized water prior to purging the well. Turbidity samples will be collected from the flow through cell outflow.

Calibration of the instruments will be completed at the beginning of each sampling day, checked in the middle of the day, and as otherwise necessary based on the functioning of the meters and equipment. Each meter will be field calibrated in accordance with the manufacturer's specifications and appropriate calibration solutions. All calibrations will be recorded in the field log. Field calibration procedures at a minimum will include the following:



- Calibration of the field instruments will be performed by trained technicians prior to the mobilization of equipment to the Site. All the instruments will be calibrated as specified by the manufacturer. Standard solutions will also be checked to determine stability and operating conditions. All results of field calibrations and measurements will be maintained in bound field logbooks at least daily when the instrument is in use. The recorded calibration information will include date and time of calibration results.
- pH meters will be calibrated according to the manufacturer's instructions prior to each use and will, at a minimum, consist of two standard buffer solutions (pH 4, 7, or 10) obtained from chemical supply houses. The pH values of the buffers will be compensated for the temperature at which the pH sample is measured. Verification checks will be completed at least once per day using a standard solution. The verification check results must agree within ± 0.05 pH standard units or recalibrations will be performed.
- All temperature measurements will be measured using a field thermometer and recorded to $\pm 0.2^\circ\text{C}$.
- Dissolved oxygen meters will be calibrated to ambient air conditions.
- Specific conductance meters will be calibrated prior to each use using a potassium chloride solution (1,000 μmhos) prepared by a qualified laboratory or chemical supplier.
- Turbidity meters will be calibrated daily prior to use by a minimum of two standards of known turbidity as prepared by the manufacturer of the instrument. These solutions should bracket the levels found in the groundwater.



- Oxidation – reduction potential probes will be checked against standard solutions (at least one) prepared by a qualified laboratory or chemical supplier.

All calibration procedures performed will be documented in the field logbook and will include the date and time of calibration, name of the person performing the calibration, reference standards used and instrument readings. If equipment fails calibration or equipment malfunction is noted during calibration or use, the equipment will be tagged and removed from service.

6.2.3 Purging Procedures

Sampling procedures will include water level measurements, calculation of well volumes, purging, and sampling activities. The following step-by-step procedures are in adherence to the EPA Region IX groundwater sampling protocols for low flow pump purging and sampling, which are based upon the method of Puls and Barcelona (EPA/540/S-9S/504). If a bladder pump cannot be inserted into a well due to bent riser piping, then a peristaltic pump will be used.

Step 1 Measure depth-to-water of every well at the Site.

Step 2 Calculate one well volume of the screened or open interval.

Step 3 Lower the low-flow pump to the mid-point of the screened interval.

Step 4 Calibrate meters.



Step 5 Begin to purge well. USEPA recommends a purge rate of 200 to 300 milliliters/minute (ml/min). The purge rate should not exceed the recharge rate (i.e., less than 0.3 feet of draw down from the static water level).

Step 6 Measure purging parameters at a minimum of one per well volume or every 3 to 5 minutes. Measurements will be collected via flow through cell for pH, temperature, specific conductivity, ORP, and DO. Turbidity will also be measured at the outflow of the flow through cell at every 3 to 5 minutes. All measurements will be recorded in the field logbook.

Step 7 After conductivity and temperature have stabilized to within 3% over three readings, pH readings differ < 0.1 standard pH units, ORP readings differ within 10 mV, and turbidity measurements differ within $\pm 10\%$, sampling can begin after the flow-through cell is disconnected.

Step 8 Using the well purging pump, the flow rate will be reduced to 100 ml/min and the unfiltered sample will be collected out of the discharge line. The date and time of the sample collection will be recorded in the field logbook.

Step 9 Using the well purging pump, the flow rate will remain at 100 ml/min and a disposable 0.45 micron in-line filter will be placed at the discharge line. The filtered sample collected at the discharge end of the in-line filter. The date and time of the sample collection will be recorded in the field logbook. Filtering the samples in-line, as proposed, with disposable filters will reduce sample agitation, exposure to the atmosphere, and decontamination concerns.

Step 10 Following groundwater sample collection, measure depth-to-bottom of every well at Site.



Purge water will be collected and containerized in a drum. The pump and sampling equipment will be decontaminated before and between each well.

6.2.4 Sample Collection

Groundwater samples will be collected using the low flow pump or peristaltic pump and tubing at a rate of 100 ml/min with the flow-through cell disconnected. Groundwater will be collected directly into laboratory prepared bottles. As per the QAPP Table 4-1, filtered groundwater samples will be collected in two-liter HDPE bottles that are preserved with nitric acid to a pH value of less than 2 standard units. Unfiltered samples will also be collected in two-liter HDPE bottles with no preservation. Immediately following sample collection and labeling of bottle, the sample will be placed in an ice cooler to maintain sample at 4° C.

6.2.5 Decontamination of Groundwater Sampling Equipment

The pump will be disassembled and components will be decontaminated in the following manner:

- Alconox and water wash;
- Potable water rinse;
- Nitric acid rinse (10% solution);
- Distilled water rinse; and,
- Air dry and store pump in plastic.

To prevent possible contamination from sampling equipment, all non-dedicated sampling devices will be decontaminated. Non-dedicated equipment is the low flow pump. Sampling equipment will be constructed of inert material (e.g., stainless, Teflon®). For non-dedicated equipment, field decontamination will be performed prior to its initial use, between sampling locations and between actual samples when more than one sample is to be collected at a given location. Decontamination is not required when subsequent use of decontaminated equipment will be documented in a field logbook. All non-dedicated sampling equipment will be decontaminated according to the following



procedure:

1. Wash equipment thoroughly with a low phosphate detergent (Alconox) and water using a brush to remove any particulate matter or surface film.
2. Rinse equipment with distilled water.
3. Rinse with diluted metric acid (10%N).
4. Triple rinse with distilled water.
5. Air dry equipment.
6. Wrap equipment in a clean plastic sleeve or in aluminum foil if not used immediately.

Spent nitric acid will be contained in bucket and placed in drums. After the groundwater sampling activities are complete, the containerized decontamination water will be sampled and disposed of properly off-site.



7.0 SAMPLE HANDLING AND ANALYSIS

All sample bottles will be identified by the use of sample labels with the sample identification. Each sample label will be filled out by the sampler to avoid any possibility of sample misidentification and attached to the sample container. Indelible ink shall be used to complete the sample labels. Each sample label will be labeled at the time of collection with, at a minimum, the following information:

- Sample identification;
- Initials of the sample collector;
- Time and date of the sample collection;
- Site name and location number (if any);
- Requested analyses;
- Any preservative added or field preparation performed; and,
- Sample designation if this sample is a quality assurance sample.

Each member of the sampling team will use a new pair of gloves at each sample location.

The field sampler will maintain custody of the samples following the procedures outlined in the following sections until the samples are properly relinquished to the laboratory or a common carrier for delivery to the laboratory. Once at the laboratory, each sample will be assigned a unique laboratory identification number that will be used for analysis assignment, sample tracking, and data reporting while the samples are at the laboratory.

7.1 SAMPLE CUSTODY/SAMPLE CONTROL

A sample is physical evidence collected from the Site. Due to the evidentiary nature of the data generated from sampling, sample custody must be traceable from the time the empty sample containers are prepared by the laboratory through the reporting of the results of the analyses. Therefore, sample control procedures have been established to ensure sample integrity. All sample containers and samples will be maintained under strict custody procedures throughout the



investigation. Sample custody is addressed in three parts: field sample collection, laboratory analysis, and final evidence files.

A sample, sample container, or evidence file will be considered under custody if:

- An item is in the actual possession of the person; or
- The item is in the view of the person, after being in actual possession of the person; or
- The item was in the person's actual physical possession but is now locked up or sealed in a tamper-proof manner; or
- The item is placed in a designated secured restricted area.

7.1.1 Field Custody Procedures

The field personnel in charge of collecting the samples will maintain custody of the samples collected. The field personnel will be responsible for documenting each sample transfer and maintaining custody of all samples until they are shipped to the laboratory or archived. All samples will be stored on ice and shipped to the laboratory in iced coolers.

7.1.2 Field Data Documentation/Field Logs

A system of logging all pertinent data collected during sampling operations will be maintained using a dedicated field logbook(s). Each page will be numbered, dated and initialed by the person making the entry. All entries will be made in indelible ink. Incorrect entries will be crossed out with a single line and verified with the recorder's initials. At the completion of the day, if a page is not complete, a diagonal line will be drawn through the remainder of the page with the recorder's signature at the bottom.

All sample locations will be recorded and referenced to the site map so that each location is permanently established. Samples will be tagged with all pertinent site information at the time of sampling. Pertinent site information to be supplied in the field logbook for each task is listed below:



The original chain-of-custody record will accompany the sample containers during transport to document their custody.

- If custody is relinquished through a common carrier for delivery to the laboratory, the following protocol will be followed:
 - In the space for the sample receiver, the name of the common carrier and the date relinquished will be written. In addition, if known, the tracking number will be included on the chain-of-custody record.
 - The original completed chain-of-custody record will be placed inside the shipping package; and,
 - The shipping package will be sealed with tape and custody seals affixed. The seals will be placed on the package in such a manner that the package cannot be opened without breaking the seals. The seals will serve to document that the shipping container was not opened during the shipment through the common parcel carrier.

7.1.4 Sample Shipment Procedures

At the end of each sampling day, all samples for chemical analysis will be packaged in shipping containers for shipment to the analytical laboratory using the following steps:

1. Check each sample bottle for a properly completed sample identification label.
2. Place the sample bottles from each location in separate plastic bags, and then seal.
3. Ship the samples in a large capacity (waterproof metal or plastic) cooler, or specific laboratory prepared sample-shipping container. Place packing material on the bottom of the cooler to prevent sample bottle breakage.



4. Place the sample bottles in the shipping container in a manner such that they do not touch and will not touch during shipment. Secure with packing material as needed to fill void space.
5. Maintain all samples at $4^{\circ}\text{C} \pm 2^{\circ}\text{C}$ during shipment. Use ice to cool the samples.
6. Place the original chain-of-custody record in a plastic bag, seal, and tape it to the inside of the shipping container lid.
7. Retain the pink copy of the chain-of-custody for the AGC QA Manager.
8. Tape the cooler drain shut. Tape the cooler or shipping container closed at a minimum of two locations.
9. Place two signed and dated custody seals across each edge of the shipping container.
10. Attach the completed shipping label to the top of the shipping container.
11. Relinquish the cooler to the courier with the required signed and dated handbill/waybill.
12. Retain receipt of the handbill/waybill as part of the permanent documentation.

If the sample coolers are not shipped but instead picked-up by the laboratory courier, step number 6 and 12 will be omitted and the chain-of-custody will be handed to and signed by the laboratory courier. The pink copy of the chain-of-custody will be maintained by the sampler and submitted to the AGC QA Manager.

7.2 QUALITY ASSURANCE/QUALITY CONTROL SAMPLING

To evaluate if field or laboratory conditions may be impacting analytical samples, equipment blanks, matrix spike and field duplicate samples will be collected according to the following paragraphs and the QAPP (Appendix A).

Equipment Blanks – Equipment blanks will be collected to ensure that the sampling equipment is clean and that the potential for cross-contamination has been minimized. One equipment blank will be collected per day or for every ten (10) samples per day (whichever is more frequent) when



sampling equipment is decontaminated. The equipment blank will be collected by pouring ultra-pure deionized water (laboratory grade) into the decontaminated sampling equipment (e.g., low flow bladder pump or stainless steel pan) and then transferring the rinsate from the equipment into the appropriate sample containers. The equipment blank will be analyzed for the identical parameters as the samples.

Matrix Spike Samples – Site specific MS samples will be submitted to the laboratory for quality control checks. The samples will be collected at the frequency of one MS for every ten (10) samples. These MS quality control (QC) samples will allow for the accuracy to be determined by the recovery rates of the compounds. The MS sample aliquots will be acquired for each matrix by providing triple the necessary sample volume for the location selected.

Field Duplicate Samples – A blind field duplicate sample will be collected to allow for the determination of sampling precision of the sampler and the analytical laboratory. One field duplicate sample will be collected for every ten (10) samples and submitted for analysis of the identical parameters as the original sample.

7.3 ANALYTICAL PARAMETERS AND TEST METHODS

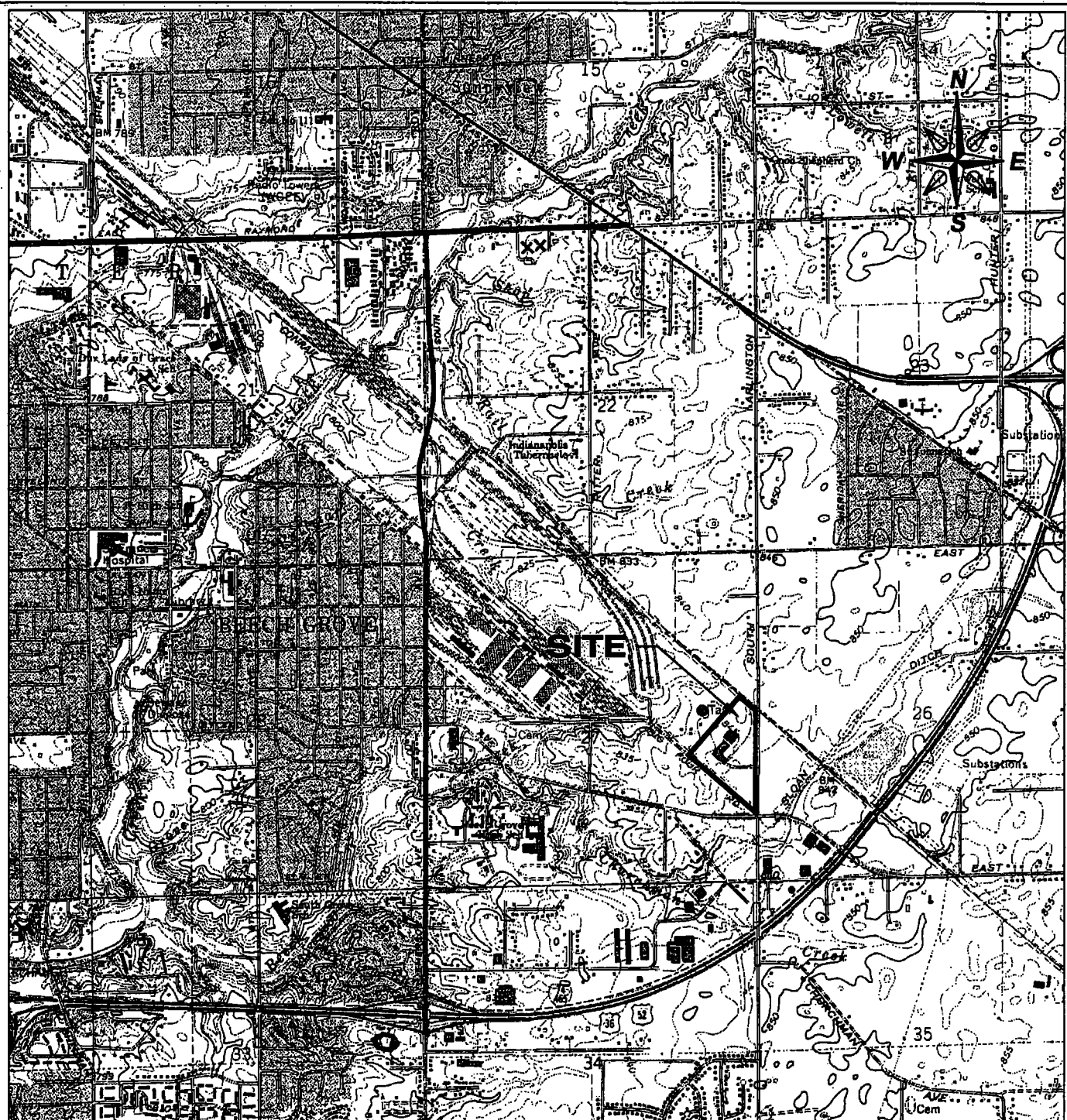
Trimatrix of Grand Rapids, Michigan will perform all analyses in accordance with the accepted USEPA SW-846 *Test Methods for Evaluating Solid Wastes: Physical/Chemical Properties (April 1998, revision 5)* methods.

The groundwater will be analyzed for antimony, arsenic, lead, and manganese by SW-846 Methods 3010A/6020, iron and sodium by SW-846 Methods 3010A/6010B, and chloride and sulfate by MCAWW325.2 and MCAWW375.2, respectively.

Analysis will include filtered and unfiltered samples to allow clarification and understanding of contribution by suspended solids (un-filtered results minus filtered results) versus actual water quality (filtered results).



Analytical data packages will be reviewed and validated by an AGC data validator as described in the QAPP. Following validation, the results will be submitted to the IDEM both in a paper and electronic format. The results will include a groundwater contour map for depth to water measurements taken at the time of sampling; a table of results specific to the sampling event; and a summary table on a well by well basis.



REF. U.S.G.S. 7 1/2 MINUTE
BEECH GROVE, IND
QUADRANGLE MAP

REFINED METALS CORPORATION

BEECH GROVE, INDIANA



Scale:	1"=2000'
Originated By:	K.M.S.
Drawn By:	P.S.G.
Checked By:	S.W.K.
Project Mgr:	P.G.S.
Dwg No.	2003-1046-05-02
Is	06 2004

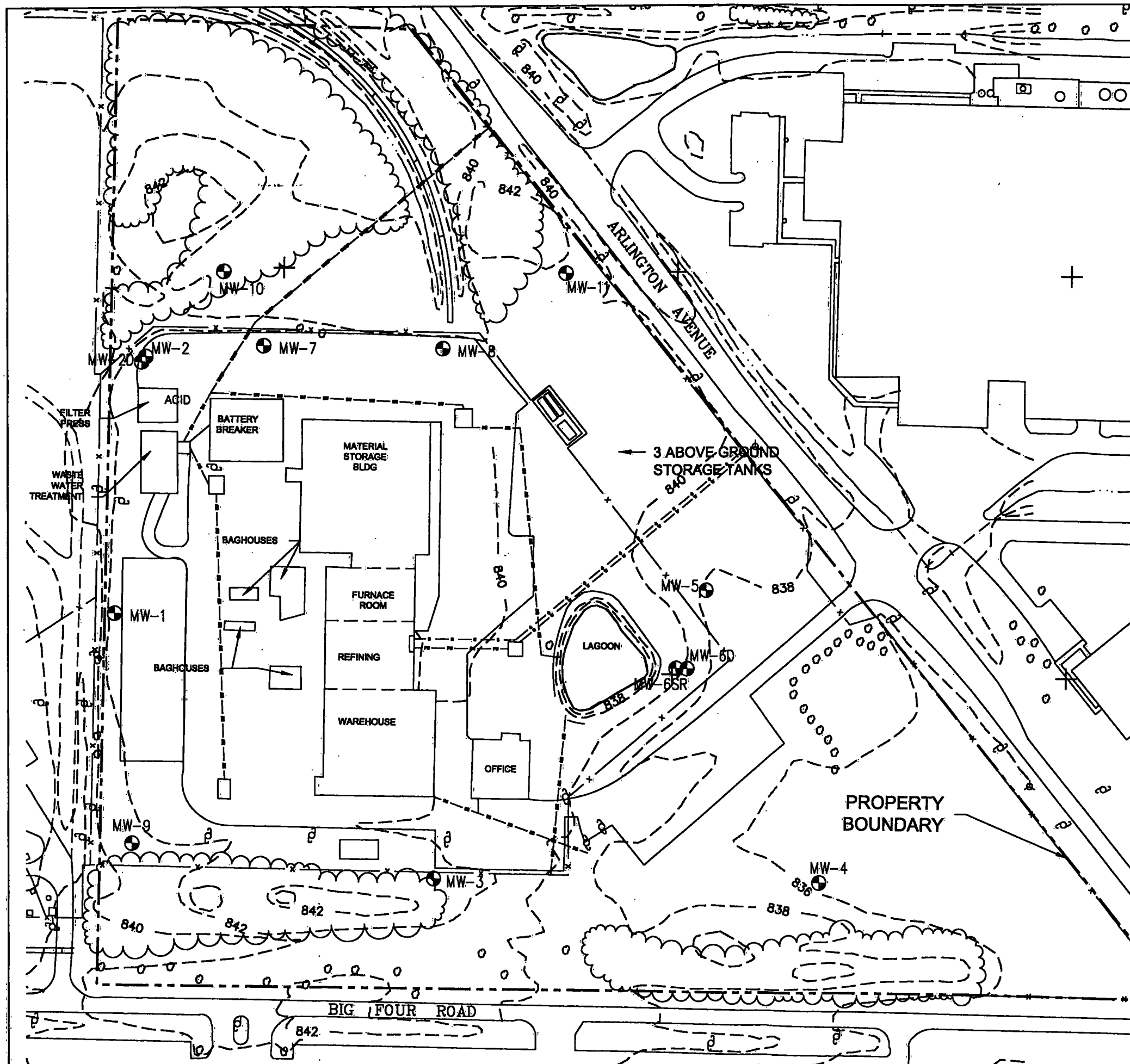
SITE LOCATION MAP



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West Chester, Pennsylvania 19380
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FAX: (610) 840-9199

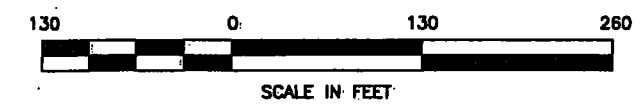
Project No. 2003-1046-05

FIGURE: 2-1



LEGEND

● MONITORING WELL LOCATION



REFINED METALS CORPORATION
BEECH GROVE, INDIANA

Scale:
1"=130'
Originated By:
B.L.
Drawn By:
V.E.N.
Checked By:
Project Mgr:
F.G.S.
Dwg. No.
2003-1046-05-0
Issued:
AUG 06 2004

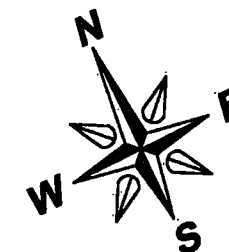
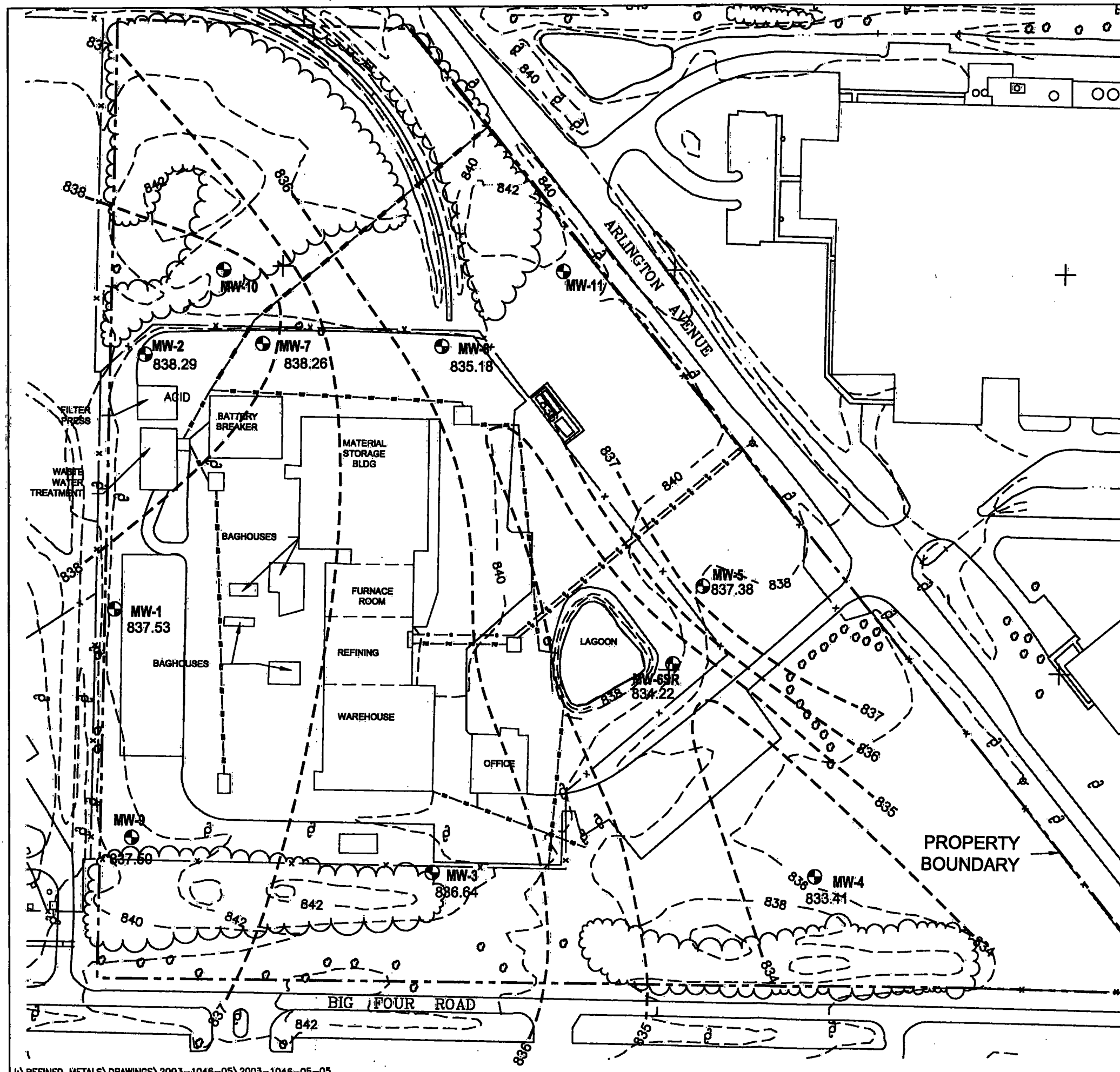
SITE PLAN



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Project No.
2003-1046-05

FIGURE: 2-2



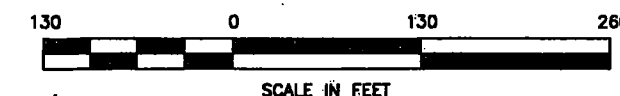
LEGEND



SHALLOW MONITORING WELL

--833--

POTENTIOMETRIC SURFACE



REFINED METALS CORPORATION
BEECH GROVE, INDIANA

SITE MONITORING WELL LOCATIONS AND
SHALLOW GROUNDWATER POTENTIOMETRIC
MAP SEPTEMBER 2001

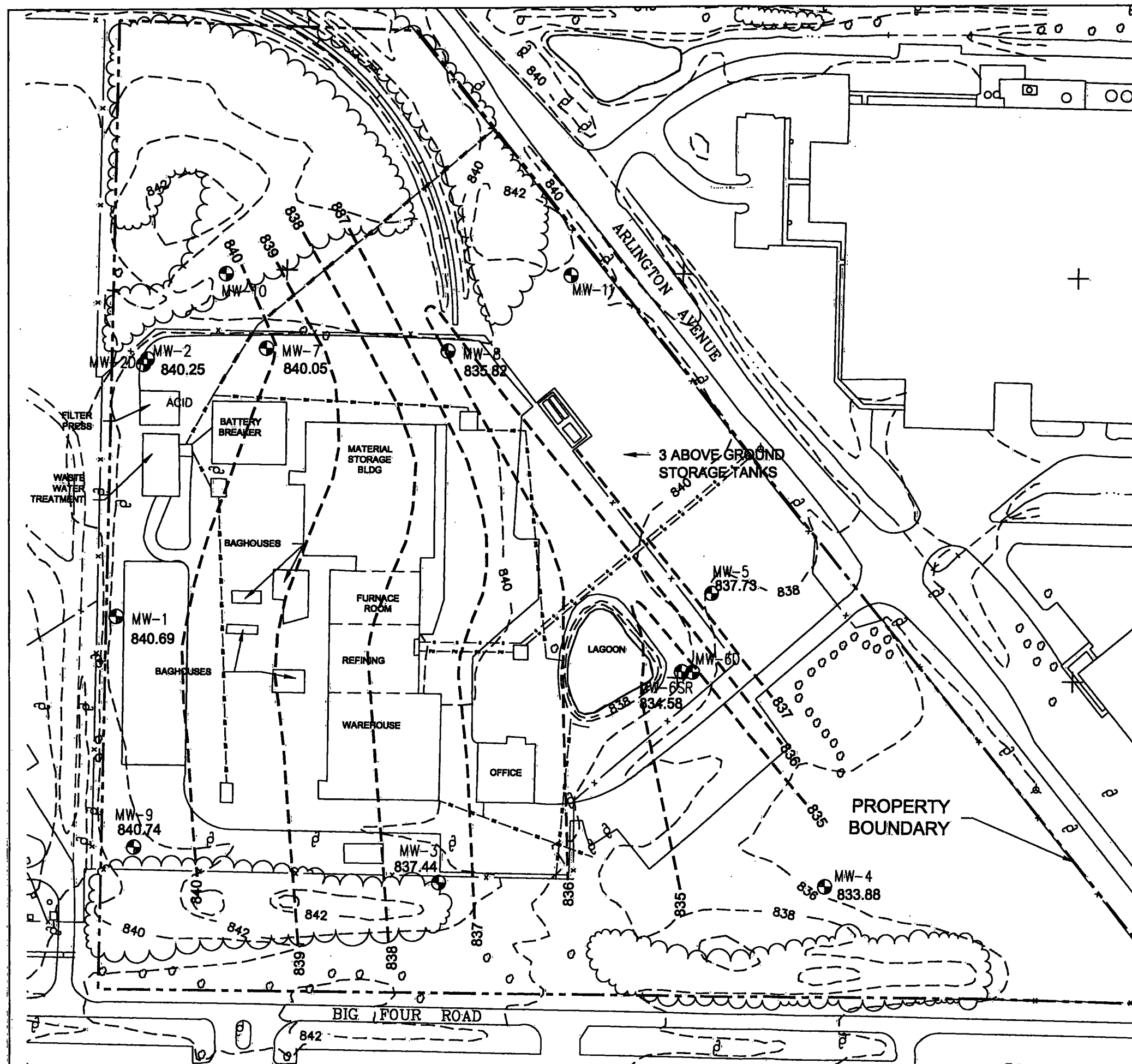


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Scale:
1"=130'
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Drawn By:
S.M.F.
Checked By:
J.S.W.
Project Mgr:
P.G.S.
Dwg No.
2003-1046-05-0
Issued
AUG 06 2004

Project No.
2003-1046-05

FIGURE: 3-1



LEGEND

● MONITORING WELL LOCATION

--833-- POTENTIOMETRIC SURFACE



REFINED METALS CORPORATION BEECH GROVE, INDIANA

SITE MONITORING WELL LOCATIONS
POTENTIOMETRIC MAP
DECEMBER 2001

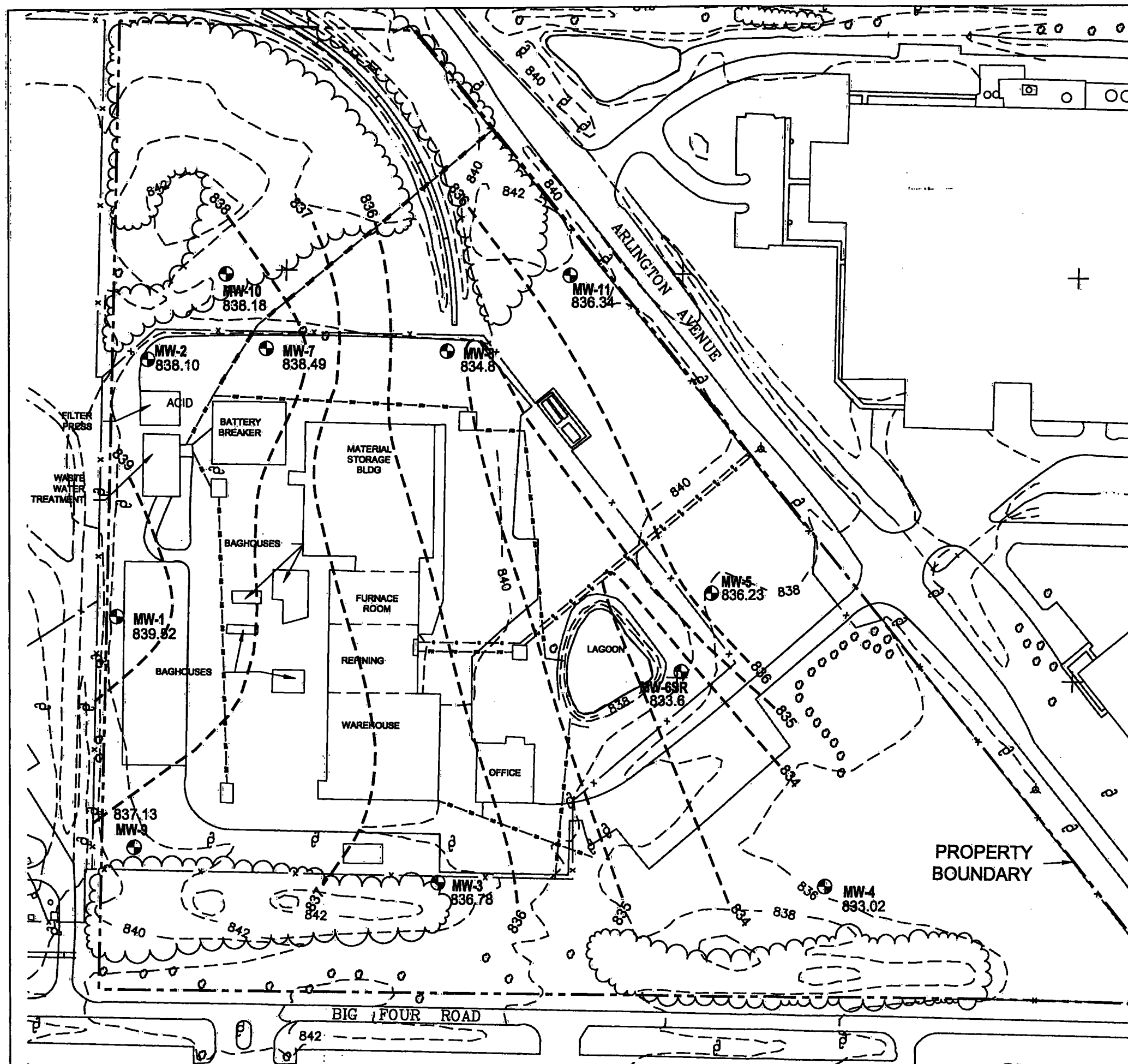


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Dwg No.
2003-1046-05-0
Issued By:
P.G.S.

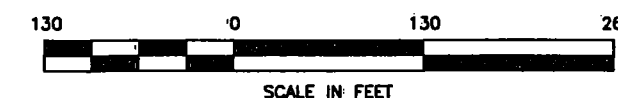
Project No.
2003-1046-05

FIGURE: 3-2



LEGEND

- SHALLOW MONITORING WELL—SURVEYED BY THE SCHNEIDER CORP., INDIANAPOLIS, IN
- 833-- POTENTIOMETRIC SURFACE.



REFINED METALS CORPORATION BEECH GROVE, INDIANA

SITE MONITORING WELL LOCATIONS AND
SHALLOW GROUNDWATER POTENTIOMETRIC
MAP OCTOBER 2003



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Scale:
1"=130'
Originated By:
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Checked By:
P.G.S.
Project Mgr:
P.G.S.
Dwg No.
2003-1046-05-05
Issued By:
M.S.G.

Project No.
2003-1046-05

FIGURE: 3-3



TABLES

TABLE 4-1
SUMMARY OF SHALLOW WELL GROUNDWATER RESULTS
 Refined Metals Corporation
 Beech Grove, Indiana

Parameter		IDEM Residential Default RISC Criteria (µg/L)	USEPA Region 9 Tap Water PRGs (µg/L)	Total Number of Samples	Total Number of Detections	Total Number of Exceedances*
Antimony	Dissolved	6	15	22	0	22
	Total	6	15	41	1	41
Arsenic	Dissolved	50	0.045	22	20	0
	Total	50	0.045	41	39	1
Barium	Dissolved	2000	2600	22	22	0
	Total	2000	2600	41	41	0
Cadmium	Dissolved	5	18	22	1	0
	Total	5	18	41	7	0
Chromium	Dissolved	100	110	22	20	0
	Total	100	110	41	18	0
Lead	Dissolved	15	NC	22	6	1
	Total	15	NC	41	25	10
Mercury	Dissolved	2	11	2	1	0
	Total	2	11	41	0	0
Selenium	Dissolved	50	180	22	7	0
	Total	50	180	41	15	0
Silver	Dissolved	182.5	180	2	0	0
	Total	182.5	180	41	0	0

NC - USEPA Region 9 does not have a tap water PRG for lead.

* Exceedance of the IDEM Residential Default RISC criteria.

The results summarized are from groundwater sampling events performed by AGC following the RCRA Facility Work Plan.



TABLE 4-2
SUMMARY OF GROUNDWATER RESULTS
Well MW-1
Refined Metals Corporation
Beech Grove, Indiana

Parameter		IDEM Residential Default RISC Criteria (µg/L)	USEPA Region 9 Tap Water PRGs (µg/L)	Sampling Events				
				9/21/1999	12/14/1999	9/22/2001	12/10/2001	10/27/2003
Antimony	Dissolved	6	15	--	--	--	10 U	10 U
	Total	6	15	10 U	10 U	10 U	10 U	10 U
Arsenic	Dissolved	50	0.045	--	--	--	22 J	21
	Total	50	0.045	21	25	33	27	24
Barium	Dissolved	2,000	2,600	--	--	--	85	69
	Total	2,000	2,600	96	86	101	93	69
Cadmium	Dissolved	5	18	--	--	--	0.2 U	0.2 U
	Total	5	18	0.2 U	0.2 U	0.2	0.2 U	0.2 U
Chromium	Dissolved	100	110	--	--	--	8.9 J	6.5
	Total	100	110	1.8 U	1 U	3.1	4	1.3
Lead	Dissolved	15	NC	--	--	--	1 U	1 U
	Total	15	NC	1.8 U	1 UJ	5.9	3.4	1 U
Mercury	Total	2	11	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Selenium	Dissolved	50	180	--	--	--	4.9 J	2 U
	Total	50	180	9	7.3	6.1 J	4	2 UJ
Silver	Total	182.5	180	0.2 R	0.2 UJ	0.2 UJ	0.2 U	0.2 U

NC - USEPA Region 9 does not have a tap water PRG for lead.

-- The sample was not analyzed for dissolved metals

Shading indicates the exceedance of the IDEM Residential Default RISC criteria.

Qualifiers: U - not detected; J - estimated; R - rejected; UJ - not detected, estimated reporting limit

The results summarized are from groundwater sampling events performed by AGC following the RCRA Facility Work Plan.



TABLE 4-3
SUMMARY OF GROUNDWATER RESULTS
Well MW-2
Refined Metals Corporation
Beech Grove, Indiana

Parameter		IDEM Residential Default RISC Criteria (µg/L)	USEPA Region 9 Tap Water PRGs (µg/L)	Sampling Events				
				9/21/1999	12/15/1999	9/22/2001	12/10/2001	10/27/2003
Antimony	Dissolved	6	15	--	--	--	10 J	10 J
	Total	6	15	10 U	10 U	10 U	10 U	10 U
Arsenic	Dissolved	50	0.045	--	--	--	9.8 J	10
	Total	50	0.045	9.8	15	12	12	15
Barium	Dissolved	2,000	2,600	--	--	--	25	22
	Total	2,000	2,600	40	45	31	48	44
Cadmium	Dissolved	5	18	--	--	--	0.2 U	0.2 U
	Total	5	18	0.2 U	0.2	0.3	0.4	0.2
Chromium	Dissolved	100	110	--	--	--	6.8 J	3.1
	Total	100	110	1 U	1.6	1 U	4.8	2.1
Lead	Dissolved	15	NC	--	--	--	6.2	2.9
	Total	15	NC	11	18	49	81	44
Mercury	Total	2	11	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Selenium	Dissolved	50	180	--	--	--	3.7 J	2 U
	Total	50	180	7.7	6	2 U	3.1	2 UJ
Silver	Total	182.5	180	0.2 R	0.2 UJ	0.2 UJ	0.2 U	0.2 U

NC - USEPA Region 9 does not have a tap water PRG for lead.

-- The sample was not analyzed for dissolved metals

Shading indicates the exceedance of the IDEM Residential Default RISC criteria.

Qualifiers: U - not detected; J - estimated; R - rejected; UJ - not detected, estimated reporting limit

The results summarized are from groundwater sampling events performed by AGC following the RCRA Facility Work Plan.



TABLE 4-4
SUMMARY OF GROUNDWATER RESULTS
Well MW-2D
Refined Metals Corporation
Beech Grove, Indiana

Parameter		IDEM Residential Default RISC Criteria (µg/L)	USEPA Region 9 Tap Water PRGs (µg/L)	Sampling Events	
				9/21/1999	12/15/1999
Antimony	Dissolved	6	15	--	--
	Total	6	15	10 U	10 U
Arsenic	Dissolved	50	0.045	--	--
	Total	50	0.045	6.3	15
Barium	Dissolved	2,000	2,600	--	--
	Total	2,000	2,600	334	311
Cadmium	Dissolved	5	18	--	--
	Total	5	18	0.2 U	0.2 U
Chromium	Dissolved	100	110	--	--
	Total	100	110	5.2	1 U
Lead	Dissolved	15	NC	--	--
	Total	15	NC	10	3.1 J
Mercury	Total	2	11	0.2 U	0.2 U
Selenium	Dissolved	50	180	--	--
	Total	50	180	2 U	2 U
Silver	Total	182.5	180	0.2 R	0.2 UJ

NC - USEPA Region 9 does not have a tap water PRG for lead.

-- The sample was not analyzed for dissolved metals

Shading indicates the exceedance of the IDEM Residential Default RISC criteria.

Qualifiers: U - not detected; J - estimated; R - rejected; UJ - not detected, estimated reporting limit

The results summarized are from groundwater sampling events performed by AGC following the RCRA Facility Work Plan.



TABLE 4-5
SUMMARY OF GROUNDWATER RESULTS
Well MW-3
Refined Metals Corporation
Beech Grove, Indiana

Parameter		IDEM Residential Default RISC Criteria (µg/L)	USEPA Region 9 Tap Water PRGs	Sampling Events				
				9/22/1999	12/14/1999	9/22/2001	12/11/2001	10/26/2003
Antimony	Dissolved	6	15	--	--	--	16 J	10 U
	Total	6	15	10 U	10 U	10 U	10 U	10 U
Arsenic	Dissolved	50	0.045	--	--	--	8.4 J	7.5
	Total	50	0.045	11	7.8	9.7	11	28
Barium	Dissolved	2,000	2,600	--	--	--	113	73
	Total	2,000	2,600	135	127	102	98	84
Cadmium	Dissolved	5	18	--	--	--	0.2 U	0.2 U
	Total	5	18	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Chromium	Dissolved	100	110	--	--	--	6.6 J	4.9
	Total	100	110	1.1	1 U	1 U	1 U	1 U
Lead	Dissolved	15	NC	--	--	--	1 U	1 U
	Total	15	NC	1 U	1 UJ	1.3	1 U	1 U
Mercury	Total	2	11	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Selenium	Dissolved	50	180	--	--	--	3.7 J	2
	Total	50	180	5.2	5.3	2 U	3.7	2 UJ
Silver	Total	182.5	180	0.2 R	0.2 UJ	0.2 UJ	0.2 U	0.2 U

NC - USEPA Region 9 does not have a tap water PRG for lead.

-- The sample was not analyzed for dissolved metals

Shading indicates the exceedance of the IDEM Residential Default RISC criteria.

Qualifiers: U - not detected; J - estimated; R - rejected; UJ - not detected, estimated reporting limit

The results summarized are from groundwater sampling events performed by AGC following the RCRA Facility Work Plan.



TABLE 4-6
SUMMARY OF GROUNDWATER RESULTS
Well MW-4
Refined Metals Corporation
Beech Grove, Indiana

Parameter		IDEM Residential Default RISC Criteria (µg/L)	USEPA Region 9 Tap Water PRGs (µg/L)	Sampling Events				
				9/22/1999	12/14/1999	9/24/2001	12/11/2001	10/26/2003
Antimony	Dissolved	6	15	--	--	--	10 U	10 U
	Total	6	15	10 U	10 U	10 U	10 U	10 U
Arsenic	Dissolved	50	0.045	--	--	--	1 UJ	1 U
	Total	50	0.045	1.8	1.6	1 U	1 U	1.3
Barium	Dissolved	2,000	2,600	--	--	--	203	213
	Total	2,000	2,600	211	204	197	187	276
Cadmium	Dissolved	5	18	--	--	--	0.2 U	0.2 U
	Total	5	18	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Chromium	Dissolved	100	110	--	--	--	3.4 J	2.1
	Total	100	110	3.1	1 U	1 U	1 U	1 U
Lead	Dissolved	15	NC	--	--	--	1 U	1 U
	Total	15	NC	1.7	1 UJ	1 U	1.5	1 U
Mercury	Total	2	11	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Selenium	Dissolved	50	180	--	--	--	2 UJ	2 U
	Total	50	180	2 U	2 U	2 U	2 U	2 UJ
Silver	Total	182.5	180	0.2 R	0.2 UJ	0.2 UJ	0.2 U	0.2 U

NC - USEPA Region 9 does not have a tap water PRG for lead.

-- The sample was not analyzed for dissolved metals

Shading indicates the exceedance of the IDEM Residential Default RISC criteria.

Qualifiers: U - not detected; J - estimated; R - rejected; UJ - not detected, estimated reporting limit

The results summarized are from groundwater sampling events performed by AGC following the RCRA Facility Work Plan.



TABLE 4-7
SUMMARY OF GROUNDWATER RESULTS
Well MW-5
Refined Metals Corporation
Beech Grove, Indiana

Parameter		IDEM Residential Default RISC Criteria (µg/L)	USEPA Region 9 Tap Water PRGs (µg/L)	Sampling Events				
				9/22/1999	12/14/1999	9/24/2001	12/11/2001	10/26/2003
Antimony	Dissolved	6	15	--	--	--	10 U	10 U
	Total	6	15	10 U	10 U	10 U	10 U	10 U
Arsenic	Dissolved	50	0.045	--	--	--	3.7 J	2.4
	Total	50	0.045	8.4	10	7.6	5.4	8.8
Barium	Dissolved	2,000	2,600	--	--	--	170	154
	Total	2,000	2,600	149	162	170	150	159
Cadmium	Dissolved	5	18	--	--	--	0.2 U	0.2 U
	Total	5	18	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Chromium	Dissolved	100	110	--	--	--	4 J	2.2
	Total	100	110	1.5	1.9	1 U	1 U	1.1
Lead	Dissolved	15	NC	--	--	--	1 U	1 U
	Total	15	NC	1 U	1 UJ	2	2.1	2.1
Mercury	Total	2	11	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Selenium	Dissolved	50	180	--	--	--	2 UJ	2 U
	Total	50	180	2 U	2.9	2 U	2 U	2 UJ
Silver	Total	182.5	180	0.2 R	0.2 UJ	0.2 UJ	0.2 U	0.2 U

NC - USEPA Region 9 does not have a tap water PRG for lead.

-- The sample was not analyzed for dissolved metals

Shading indicates the exceedance of the IDEM Residential Default RISC criteria.

Qualifiers: U - not detected; J - estimated; R - rejected; UJ - not detected, estimated reporting limit

The results summarized are from groundwater sampling events performed by AGC following the RCRA Facility Work Plan.



TABLE 4-8
SUMMARY OF GROUNDWATER RESULTS
Well MW-6
Refined Metals Corporation
Beech Grove, Indiana

Parameter		IDEM Residential Default RISC Criteria (µg/L)	USEPA Region 9 Tap Water PRGs (µg/L)	Sampling Events				
				9/23/1999	12/15/1999	9/24/2001	12/11/2001	10/26/2003
Antimony	Dissolved	6	15	10 U	10 U	--	10 U	10 U
	Total	6	15	10 U	10 U	10 U	10 U	10 U
Arsenic	Dissolved	50	0.045	1.7	1.6	--	1.4 J	1.2
	Total	50	0.045	8.8 J	3.1	1.9	2.2	7.6
Barium	Dissolved	2000	2600	39	36	--	89	117
	Total	2000	2600	218	82	92	79	228
Cadmium	Dissolved	5	18	0.2 U	0.2 U	--	0.2 U	0.2 U
	Total	5	18	0.2	0.2 U	0.2 U	0.2 U	0.2 U
Chromium	Dissolved	100	110	8.7	1 U	--	3.8 J	2.1
	Total	100	110	26	7.5	1 U	1 U	4.5
Lead	Dissolved	15	NC	1 U	1 UJ	--	1 U	1 U
	Total	15	NC	21	4.9 J	1 U	1.3	2.7
Mercury	Dissolved	2	11	0.2 U	0.2	--	--	--
	Total	2	11	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Selenium	Dissolved	50	180	2.9 J	2 U	--	2 UJ	2 U
	Total	50	180	4.9 J	2.1	2 U	2 U	2 UJ
Silver	Dissolved	182.5	180	0.2 U	0.2 UJ	--	--	--
	Total	182.5	180	0.2 UJ	0.2 UJ	0.2 UJ	0.2 U	0.2 U

The results summarized are from groundwater sampling events performed by AGC following the RCRA Facility Work Plan.



TABLE 4-9
SUMMARY OF GROUNDWATER RESULTS
Well MW-6D
Refined Metals Corporation
Beech Grove, Indiana

Parameter		IDEM Residential Default RISC Criteria (µg/L)	USEPA Region 9 Tap Water PRGs (µg/L)	Sampling Events	
				9/21/1999	12/15/1999
Antimony	Dissolved	6	15	--	--
	Total	6	15	104	104
Arsenic	Dissolved	50	0.045	--	--
	Total	50	0.045	24	31
Barium	Dissolved	2,000	2,600	--	--
	Total	2,000	2,600	293	301
Cadmium	Dissolved	5	18	--	--
	Total	5	18	0.2 U	0.2 U
Chromium	Dissolved	100	110	--	--
	Total	100	110	2	1 U
Lead	Dissolved	15	NC	--	--
	Total	15	NC	2.2	1.2 J
Mercury	Total	2	11	0.2 U	0.2 U
Selenium	Dissolved	50	180	--	--
	Total	50	180	2.1	2 U
Silver	Total	182.5	180	0.2 R	0.2 UJ

NC - USEPA Region 9 does not have a tap water PRG for lead.

-- The sample was not analyzed for dissolved metals

Shading indicates the exceedance of the IDEM Residential Default RISC criteria.

Qualifiers: U - not detected; J - estimated; R - rejected; UJ - not detected, estimated reporting limit

The results summarized are from groundwater sampling events performed by AGC following the RCRA Facility Work Plan.



TABLE 4-10
SUMMARY OF GROUNDWATER RESULTS
Well MW-7
Refined Metals Corporation
Beech Grove, Indiana

Parameter		IDEM Residential Default RISC Criteria (µg/L)	USEPA Region 9 Tap Water PRGs (µg/L)	Sampling Events		
				9/22/2001	12/11/2001	10/27/2003
Antimony	Dissolved	6	15	--	10 U	10 U
	Total	6	15	10 U	10 U	10 U
Arsenic	Dissolved	50	0.045	--	30 J	25
	Total	50	0.045	25	26	290
Barium	Dissolved	2,000	2,600	--	23	45
	Total	2,000	2,600	21	25	17
Cadmium	Dissolved	5	18	--	0.2 U	0.2 U
	Total	5	18	0.2 U	0.2 U	0.2 U
Chromium	Dissolved	100	110	--	13 J	7.4
	Total	100	110	1 U	2.8	1.9
Lead	Dissolved	15	NC	--	2.5	1
	Total	15	NC	10	17	17
Mercury	Total	2	11	0.2 U	0.2 U	0.2 U
Selenium	Dissolved	50	180	--	6.5 J	2 U
	Total	50	180	3.7 J	5.7	2 UJ
Silver	Total	182.5	180	0.2 UJ	0.2 U	0.2 U

NC - USEPA Region 9 does not have a tap water PRG for lead.

-- The sample was not analyzed for dissolved metals

Shading indicates the exceedance of the IDEM Residential Default RISC criteria.

Qualifiers: U - not detected; J - estimated; R - rejected; UJ - not detected, estimated reporting limit

The results summarized are from groundwater sampling events performed by AGC following the RCRA Facility Work Plan.



TABLE 4-11
SUMMARY OF GROUNDWATER RESULTS
Well MW-8
Refined Metals Corporation
Beech Grove, Indiana

Parameter		IDEM Residential Default RISC Criteria (µg/L)	USEPA Region 9 Tap Water PRGs	Sampling Events		
				9/22/2001	12/11/2001	10/28/2003
Antimony	Dissolved	6	15	--	2012	1015
	Total	6	15	13	100	100
Arsenic	Dissolved	50	0.045	--	14 J	17
	Total	50	0.045	5.1	13	19
Barium	Dissolved	2,000	2,600	--	135	79
	Total	2,000	2,600	133	123	89
Cadmium	Dissolved	5	18	--	0.3	0.2 U
	Total	5	18	0.8	0.4	0.2 U
Chromium	Dissolved	100	110	--	3.8 J	2.9
	Total	100	110	1 U	1 U	1.1 U
Lead	Dissolved	15	NC	--	11	15
	Total	15	NC	21	23	20
Mercury	Total	2	11	0.2 U	0.2 U	0.2 U
Selenium	Dissolved	50	180	--	2 UJ	2 U
	Total	50	180	2 U	2 U	2 UJ
Silver	Total	182.5	180	0.2 UJ	0.2 U	0.2 U

NC - USEPA Region 9 does not have a tap water PRG for lead.

-- The sample was not analyzed for dissolved metals

Shading indicates the exceedance of the IDEM Residential Default RISC criteria.

Qualifiers: U - not detected; J - estimated; R - rejected; UJ - not detected, estimated reporting limit

The results summarized are from groundwater sampling events performed by AGC following the RCRA Facility Work Plan.



TABLE 4-12
SUMMARY OF GROUNDWATER RESULTS
Well MW-9
Refined Metals Corporation
Beech Grove, Indiana

Parameter		IDEM Residential Default RISC Criteria (µg/L)	USEPA Region 9 Tap Water PRGs	Sampling Events		
				9/22/2001	12/10/2001	10/27/2003
Antimony	Dissolved	6	15	--	10.0 R	10.0 R
	Total	6	15	10.0 R	10.0 R	10.0 R
Arsenic	Dissolved	50	0.045	--	3.7 J	2.7
	Total	50	0.045	7.7	4	4.2
Barium	Dissolved	2,000	2,600	--	68	41
	Total	2,000	2,600	137	68	43
Cadmium	Dissolved	5	18	--	0.2 U	0.2 U
	Total	5	18	0.2 U	0.2 U	0.2 U
Chromium	Dissolved	100	110	--	3.8 J	1.9
	Total	100	110	1 U	2.2	1 U
Lead	Dissolved	15	NC	--	1 U	1 U
	Total	15	NC	1.6	1 U	1
Mercury	Total	2	11	0.2 U	0.2 U	0.2 U
Selenium	Dissolved	50	180	--	2 UJ	2 U
	Total	50	180	2 U	2 U	2 UJ
Silver	Total	182.5	180	0.2 UJ	0.2 U	0.2 U

NC - USEPA Region 9 does not have a tap water PRG for lead.

-- The sample was not analyzed for dissolved metals.

Shading indicates the exceedance of the IDEM Residential Default RISC criteria.

Qualifiers: U - not detected; J - estimated; R - rejected; UJ - not detected, estimated reporting limit

The results summarized are from groundwater sampling events performed by AGC following the RCRA Facility Work Plan.



TABLE 4-13
SUMMARY OF GROUNDWATER RESULTS
Well MW-10
Refined Metals Corporation
Beech Grove, Indiana

Parameter		IDEM Residential Default RISC Criteria (µg/L)	USEPA Region 9 Tap Water PRGs	Sampling Event 10/28/2003
Antimony	Dissolved	6	15	10 U
	Total	6	15	10 U
Arsenic	Dissolved	50	0.045	7.5
	Total	50	0.045	24
Barium	Dissolved	2,000	2,600	16
	Total	2,000	2,600	71
Cadmium	Dissolved	5	18	0.2 U
	Total	5	18	0.2 U
Chromium	Dissolved	100	110	5.2
	Total	100	110	1.6 U
Lead	Dissolved	15	NC	1 U
	Total	15	NC	1 U
Mercury	Total	2	11	0.2 U
Selenium	Dissolved	50	180	2.3
	Total	50	180	2 U
Silver	Total	182.5	180	0.2 U

NC - USEPA Region 9 does not have a tap water PRG for lead.

-- The sample was not analyzed for dissolved metals

Shading indicates the exceedance of the IDEM Residential Default RISC criteria.

Qualifiers: U - not detected; J - estimated; R - rejected; UJ - not detected, estimated reporting limit

The results summarized are from groundwater sampling events performed by AGC following the RCRA Facility Work Plan.



TABLE 4-14
SUMMARY OF GROUNDWATER RESULTS
Well MW-11
Refined Metals Corporation
Beech Grove, Indiana

Parameter		IDEM Residential Default RISC Criteria (µg/L)	USEPA Region 9 Tap Water PRGs (µg/L)	Sampling Event 10/27/2003
Antimony	Dissolved	6	15	10.2
	Total	6	15	10.2
Arsenic	Dissolved	50	0.045	7.1
	Total	50	0.045	7.1
Barium	Dissolved	2,000	2,600	167
	Total	2,000	2,600	167
Cadmium	Dissolved	5	18	0.2 U
	Total	5	18	0.2 U
Chromium	Dissolved	100	110	1 U
	Total	100	110	1.1
Lead	Dissolved	15	NC	1 U
	Total	15	NC	1 U
Mercury	Total	2	11	0.2 U
Selenium	Dissolved	50	180	2 U
	Total	50	180	2 UJ
Silver	Total	182.5	180	0.2 U

NC - USEPA Region 9 does not have a tap water PRG for lead.

-- The sample was not analyzed for dissolved metals

Shading indicates the exceedance of the IDEM Residential Default RISC criteria.

Qualifiers: U - not detected; J - estimated; R - rejected; UJ - not detected, estimated reporting limit

The results summarized are from groundwater sampling events performed by AGC following the RCRA Facility Work Plan.



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LEXINGTON, LOUISVILLE, KENTUCKY

SUBSURFACE LOG

Page 1 of 1

JECT NAME: Marion, Indiana
FACE ELEVATION: R/A
USER: Craig Avery/David Mallins
JECT TYPE: Monitoring Well Installation
I NUMBER: 1 TOTAL DEPTH: 30.0'

PROJECT NUMBER: 90226
LOCATION: Hole #1
DATE STARTED: 10/11/90
LOGGED BY: Don Atwood
DEPTH TO WATER: IMMEDIATE: 6.0'
DEPTH TO WATER: DATE AFTER COMPLETION: ---

LITHOLOGY		DESCRIPTION	OVERBURDEN	SAMP. NO.	DEPTH	SEC. FT.	BLOWS	TYPE	REMARKS
IV.	DEPTH								
	5.0	Fill: intermixed clay, sandy clay, and construction debris (Excavated with backhoe)							
	21.0	Silty clay, brown, moist, medium stiff; with some sand and gravel		1	10.0-11.5	1.5	3/3/5	SPT	
				2	15.0-16.5	1.0	5/7/14	SPT	
				3	20.0-21.5	1.0	6/16/29	SPT	
	30.0	Sand, brown, fine to medium grained, medium dense		4	28.5-30.0	0.0	30+	SPT	
		Bottom of Hole - 30.0'							

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LEXINGTON, LOUISVILLE, KENTUCKY

SUBSURFACE LOG

Page 1 of 1

JOB#: Marion, Indiana PROJECT NUMBER: 90226
 SUBJECT NAME: Refined Metals Corporation LOCATION: Hole #2
 SURFACE ELEVATION: N/A DATE STARTED: 10/10/90 COMPLETED: 10/11/90
 UTILITIES: Craig Avery/David Mullins LOGGED BY: Don Armour
 SUBJECT TYPE: Monitoring Well Installation DEPTH TO WATER: IMMEDIATE: 9.7' (0730 hrs.; 10/11/90)
 WELL NUMBER: 2 TOTAL DEPTH: 30.0' DEPTH TO WATER: DAYS AFTER COMPL: 6.9' (1515 hrs.; 10/11/90)

LITHOLOGY		DESCRIPTION	OVERBURDEN	SAMP. NO.	DEPTH	REC. FT.	BLOW	TYPE	REMARKS
LEV.	DEPTH								
	0.0	Silty clay, brown, moist, medium stiff; with some sand and gravel		1	5.0-6.3	1.3	4/3/5	SPT	
				2	10.0-11.3	1.3	4/6/8	SPT	
				3	15.0-16.3	1.0	5/10/18	SPT	
	20.0			4	20.0-21.3	0.0	3/5/13	SPT	
		Clayey sand and silt, brown, wet, medium dense		5	25.0-26.3	1.0	8/12/20	SPT	
	28.0			6	28.3-30.0	1.3	10/22/31	SPT	
	30.0	Clay, gray, moist, stiff; with occasional gravel							
		Bottom of Hole - 30.0'							

SUBSPACE LOC

HTI: Marion, Indiana
 WPC NAME: Refined Metals Corporation
 WPC ELEVATION: N/A
 OWNER: Craig Avery/David Mullins
 WPC TYPE: Monitoring Well Installation
 WPC NUMBER: 3 TOTAL DEPTH: 21.5'

PROJECT NUMBER: 90226
LOCATION: Hole #1
DATE STARTED: 10/17/90
LOGGED BY: Don ARMOUR
DEPTH TO WATER: IMMEDIATE:
DEPTH TO WATER: DAYS AFTER COMPLETION: 10/17/90

LITHOLOGY		DESCRIPTION	OVERBURDEN	SAMP. NO.	DEPTH	REC. FT.	BLOWS	TYPE	REMARKS
LEV.	DEPTH								
		Silty clay, brown, moist, medium stiff; with some sand and gravel							
	13.0								
		Clayey sand and silt, brown, wet, medium dense							
	20.0								
	21.5	Clay, gray, moist, stiff; with occasional gravel							
		Bottom of Hole - 21.5'							

ΣΥΣΤΗΛΟΙ ΛΟΓ

JECI NAME: Marion, Indiana
 RACE ELEVATION: Refined Metals Corporation
 RACE: N/A
 ILLERS: Craig Avery/David Mullins
 OBJECT TYPE: Monitoring Well Installation
 LE NUMBER: 4 TOTAL DEPTH: 26.0'

PROJECT NUMBER: 90226
LOCATION: Hole #4
DATE STARTED: 10/15/90 COMPLETED: 10/15/90
LOGGED BY: Don Ambrose
DEPTH TO WATER: IMMEDIATE: —
DEPTH TO WATER: DAYS AFTER COMPL: —

LITHOLOGY		DESCRIPTION	OVERBURDEN	SAMP. NO.	DEPTH	REC. FT.	BLOWS	TYPE	REMARKS
LEV.	DEPTH								
	13.0	silty clay, brown, moist, medium stiff; with some sand and gravel		1	5.0-6.5	1.5	2/1/2	SPT	
			2	10.0-11.5	1.0	5/9/11	SPT		
			3	15.0-16.5	1.0	12/17/13	SPT		
	22.0	Clayey sand and silt, brown, wet, medium dense		4	20.0-21.5	1.0	16/38/43	SPT	
	26.0	Clay, gray, moist, very stiff with occasional gravel		5	24.5-26.0	1.5	9/22/20	SPT	
		Bottom of Hole - 26.0'							

FULLER, MOSBARGER, SCOTT AND MAY
CIVIL ENGINEERS, INC.
LEXINGTON, LOUISVILLE, KENTUCKY

SUBSURFACE LOG

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CLIENT: Marion, Indiana OWNER: Refined Metals Corporation PROJECT TYPE: Monitoring Well Installation WELL NUMBER: 5	PROJECT NUMBER: 90226 LOCATION: Hole #5 DATE SOUNDED: 10/12/90 LOGGED BY: Don Armour DEPTH TO WATER: IMMEDIATE DEPTH TO WATER: DAYS AFTER CONFL: —	COMPLETED: 10/12/90 10' (0900 hrs.: 10/12/90)
TOTAL DEPTH: 25.0'		

LITHOLOGY		DESCRIPTION	OVERBURDEN	SAMP. NO.	DEPTH	REC. FT.	BLOWS	TYPE	REMARKS
LEV.	DEPTH								
	1.0	Topsoil							
		Silty clay, brown, moist, medium stiff; with some sand and gravel		1	5.0-6.5	1.5	2/3/3	SPT	
				2	10.0-11.5	1.0	5/8/17	SPT	
	15.0			3	15.0-16.5	1.0	14/20/14	SPT	
		Clayey sand and silt, brown, wet, medium dense							
		Gravel 16.0-17.0							
	25.0								
		Bottom of Hole - 25.0'							

BORING LOG


PAGE 1 OF 1

PROJECT NUMBER: 98-478-03		PROJECT NAME: RMC - Beech Grove	
BORING / WELL NUMBER: MW-65		LOCATION: Beech Grove Indiana	
DIAMETER: 2"	WATER DEPTH: 16.0'	DATE/TIME: 8/12/99 1400	
GEOLOGIST: Eric Stanke	COMPLETION DEPTH: 17.0'	DATE STARTED: 8/12/99	
DRILLING METHOD: HSA	SAMPLING METHOD: Split Spoon	DATE COMPLETED: 8/12/99	
DRILLING SUBCONTRACTOR: Boar + Longyear	DEVELOPMENT METHOD: hose block/pump	YIELD: ~ 0.5 gpm	

DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 6 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
0.0'-1.0' SILT, tan with a trace of organics and subangular to angular gravel - dry (lt)							On 8/12/99 use 6" HSA and split spoons to determine where to set well. Well installed on 8/12/99
1.0'-5.0' SILT, tan with a trace of subangular to angular gravel - dry (5.0')							
5.0'-9.0' SILT, black with a trace of organics - moist (medium dense) (9.0')							
9.0'-10.5' CLAY, light brown with a trace of silt and angular gravel - moist (medium dense) (10.5')							
10.5'-12.0' CLAY, brown with a trace of angular to subrounded gravel - wet (loose) (12.0')							
12.0'-16.0' CLAY, brown and dark brown mottled with a trace of fine sand, silt and angular gravel - moist (medium dense) (16.0')							
16.0'-16.5' SILT, light brown with angular to rounded gravel - wet (loose) (16.5')							
16.5'-21.0' CLAY, dark gray with a trace of fine sand and gravel - moist (medium dense) (21.0')							
21.0'-24.5' fine sandy SILT, gray - moist (loose) (24.5')							
24.5'-31.0' medium SAND, gray with a trace of silt - moist (loose)							
Boring terminated at 31.0'. Well screens from 7.0' to 17.0' bgs.							

BORING LOG







PAGE 1 OF 1

PROJECT NUMBER: 98-478-DS		PROJECT NAME: RMC - Beech Grove					
BORING / WELL NUMBER: MW-6SR		LOCATION: Beech Grove, Indiana					
DIAMETER: 4"		WATER DEPTH: 12.5'		DATE/TIME: 8/21/01			
GEOLOGIST: Brendan O'Donnell		COMPLETION DEPTH: 30.0'		DATE STARTED: 8/21/01			
DRILLING METHOD: HSA		SAMPLING METHOD: HSA/SS		DATE COMPLETED: 8/21/01			
DRILLING SUBCONTRACTOR: Board Longyear		DEVELOPMENT METHOD: Surged Block		YIELD: —			
DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 6 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
0.0-5.0 Clay, brown-orange, dry with topsoil and sand, STIFF			8,8 13,16 7,10 11,16	data not collected	NA		Well Construction
5.0-10.0 Clay, brown-gray, moist STIFF		5	5,7 11,15 5,10 11,13 10,10 14,12				Riser: Sch. 40 PVC 0'-20'
10.0-15.0 sandy silt, brown-gray, STIFF, moist to saturated, (ML)		10	— — 9,9 11,13 14,12				Screen: 0.010 slot Sch. 40 PVC 20'-30'
15.0-20.0 sandy silt, gray, STIFF Saturated, (ML)		15	15,15 — 13,14 15,18				Sand Pack: #1 sand 18'-30'
20.0-25.0 sandy silt, gray med. STIFF Saturated, ML		20	8,8 7,8 5,1 9,10 14,10				Bentonite: 16'-18' seal
25.0-30.5 sandy silt, gray, Very STIFF Saturated, ML		25	10,10 16,16 21,21 100,5				GROUT: 459, type 10 Portland 570 Bentonite 0'-16'
		30					Shell by tube Collected at: 10'-12' 16'-18' For Sieve & Hydr. Testing

BORING LOG

PAGE 1 OF 1

PROJECT NUMBER: 98-478-0	PROJECT NAME: RMC - Beech Grove	
BORING / WELL NUMBER: MW-7	LOCATION: Beech Grove, Indiana	
DIAMETER: 4"	WATER DEPTH: 12.5'	DATE/TIME: 8/22/01
GEOLOGIST: Brendan O'Donnell	COMPLETION DEPTH: 25'	DATE STARTED: 8/24/01
DRILLING METHOD: HSA	SAMPLING METHOD: HSA/SS	DATE COMPLETED: 8/23/01
DRILLING SUBCONTRACTOR: Beart Longyear	DEVELOPMENT METHOD: Surge Block	YIELD: —

DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 6 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
0.0' - 5.0' Clay, gray to greenish gray moist to dry		0	1	data not collected	NA		Well Construction
		1	9.9				Riser: Sch. 40 PVC
		2	12.2				0' - 15'
		3	14.10				Screen: Odo Stat
		4	19.11				Sch. 40 PVC
		5	7.11				
		6	14.13				
		7	8.11				Sandpack: #1 Sand
		8	12.11				15' - 25'
		9	5.6				
		10	6.12				Bentamite: 15' - 15'
		11	7.14				Seal
5.0' - 10.0' Clay, brown, dry to moist		12	22.49	data not collected	NA		grout: 0' - 11'
		13	14.14				
		14	28.34				
		15	5.13				
		16	24.37				
		17	14.15				
		18	19.32				
		19	15.10				
		20	4.28				
		21	18.24				
		22	21.49				
		23	15.16				
10.0' - 15.0' sandy silt, trace gravel brown to dark brown, stiff moist to saturated, ML		24	11.25	data not collected	NA		
		25	4.14				
		26	38.68				
		27					
		28					
		29					
		30					
		31					
		32					
		33					
		34					
		35					
		36					
15.0' - 20.0' sandy silt, light brown and gray, saturated, very stiff, ML		37		data not collected	NA		
		38					
		39					
		40					
		41					
		42					
		43					
		44					
		45					
		46					
		47					
		48					
		49					
		50					
20.0' - 25.0' sandy silt, light gray saturated, very stiff ML		51		data not collected	NA		
		52					
		53					
		54					
		55					
		56					
		57					
		58					
		59					
		60					
		61					
		62					
		63					
		64					
25.0' - 28.0' sandy silt, light gray saturated, very stiff - Hard (ML)		65		data not collected	NA		
		66					
		67					
		68					
		69					
		70					
		71					
		72					
		73					
		74					
		75					
		76					
		77					
		78					
Boring terminated at 28'		79					

BORING LOG

PAGE 1 OF 1

PROJECT NUMBER: 98-478-05		PROJECT NAME: RNC - Beech Grove	
BORING / WELL NUMBER: MW-8		LOCATION: Beech Grove, Indiana	
DIAMETER: 4"	WATER DEPTH: 10.5'	DATE/TIME: 8/23/01	
GEOLOGIST: Brendan O'Donnell	COMPLETION DEPTH: 30.0'	DATE STARTED: 8/21/01	
DRILLING METHOD: HSA	SAMPLING METHOD: HSA/SS	DATE COMPLETED: 8/21/01	
DRILLING SUBCONTRACTOR: Boert Longyear	DEVELOPMENT METHOD: Surged Block	YIELD: —	

DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 6 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
0.0' - 5.0' Clay with construction debris (Fill) brown to dark brown, moist, FL			1 1.6 11.1		NA		Well construction Riser: Sch. 40 PVC 0'-2.0'
5.0' - 10.0' Same as above, FL		5	5.6 9.6 3.3 3.4				Screen: 0.010 slot Sch. 40 PVC 2.0'-5.0'
10.0' - 15.0' sandy Silt, gray, medium Stiff, moist, ML		10	5.4 5.7 7.11 12.13				Sand: #1 Sand 0'-18'
15.0' - 20.0' sandy Silt, gray, M. Stiff saturated, ML		15	5.6 8.9 6.8 9.18 6.7				Centrifuge: 16'-18'
20.0' - 25.0' sandy Silt, gray, M. Stiff saturated, ML		20	9.13 6.7 7.8 7.11 10.15				Seal
25.0' - 30.0' sandy Silt, gray, Stiff saturated, ML		25	13.13 16.4 6.7 13.23 9.24				Grout: 0'-16' 450/590 Type II Portland Cement/Bedrock
Boring terminated at 30'		30	33.38				

BORING LOG

PAGE 1 OF 1

PROJECT NUMBER: 18-478-05	PROJECT NAME: RMC Beech Grove	
BORING / WELL NUMBER: MW-9	LOCATION: Beech Grove, Indiana	
DIAMETER: 4"	WATER DEPTH: 15.3'	DATE/TIME: 8/23/01
GEOLOGIST: Brendan O'Donnell	COMPLETION DEPTH: 25'	DATE STARTED: 8/22/01
DRILLING METHOD: HSA	SAMPLING METHOD: HSA/SS	DATE COMPLETED: 8/23/01
DRILLING SUBCONTRACTOR: R. and L. Longyear	DEVELOPMENT METHOD: Suck & Wash	YIELD: —

DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 6 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
0.0' - 5.0' Sand with construction debris, dry, FL			15, 12 10, 10 7, 7 7, 7 8, 8		NA		Well Construction Riser: Sch. 40 PVC 0' - 15'
5.0' - 10.0' same as above, FL			10, 10 4, 5 5, 11 5, 7 6, 8				Screen: 0.0105/ft Sch. 40 PVC 15' - 25' Sand: #1 Sand PAC 13' - 15'
10.0' - 15.0' sandy silt, light gray, medium stiff, ML			5, 5 5, 8 7, 8 9, 11 6, 6				Bentonite: Seal 11' - 13' grout: 0' - 11'
15.0' - 20.0' sand silt, light gray, stiff, ML			2, 2 3, 4 9, 11 11, 13 13, 27				
20.0' - 26.0' sandy silt, light gray, Hard, saturated (ML)			4, 47 5, 13 2, 29 3, 41 1, 12				Steel by tube Completed at 22' - 24' and 24' - 26' for sieve and hydro testing
Boring terminated at 26'							

BORING LOG

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PROJECT NUMBER: 98-478-03		PROJECT NAME: RML - Beech Grove			
BORING / WELL NUMBER: mw-10		LOCATION: Beech Grove Indiana			
DIAMETER: No well installed		WATER DEPTH: none encountered		DATE/TIME:	
GEOLOGIST: Eric Stanke		COMPLETION DEPTH: 129.5'		DATE STARTED: 8/23/99	
DRILLING METHOD: HSA and Roto-Sonic		SAMPLING METHOD: HSA/SS & Roto-Sonic		DATE COMPLETED: 8/31/99	
DRILLING SUBCONTRACTOR: Beart Longyear		DEVELOPMENT METHOD: Not Applicable		YIELD: Not Applicable	

DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 6 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
0.0'-3.0' CLAY, brown with construction debris - dry (fill) (Loose) <div style="text-align: right;">(3.0')</div>							On 8/23/99 use Roto-Sonic rig to determine what depth to overdrive with 10' Augers and set 8" surface casing to 29.5' and gravel casing in on 8/25/99.
3.0'-9.0' CLAY, brown - moist (Loose) <div style="text-align: right;">(9.0')</div>							
9.0'-15.0' Clayey SILT, brown to dark brown - moist (Loose) <div style="text-align: right;">(15.0')</div>							
15.0'-20.0' Fine sandy CLAY, light brown and gray with a trace of gravel - moist (Loose) <div style="text-align: right;">(20.0')</div>							
20.0'-23.0' SILT, dark orange brown with a trace of subrounded to subangular gravel - moist (Loose) <div style="text-align: right;">(23.0')</div>							
23.0'-26.0' Fine sandy SILT, light to dark gray with a trace of subangular to subrounded gravel - dry (medium dense) <div style="text-align: right;">(26.0')</div>							
26.0'-28.0' Fine SAND, gray with a trace of silt and subangular to subrounded gravel - dry (medium to very dense) <div style="text-align: right;">(28.0')</div>							
28.0'-32.0' SILT, dark gray with a trace of subangular to subrounded gravel - dry (medium to very dense) <div style="text-align: right;">(32.0')</div>						Surface Casing set to 29.5' Begin 8" Roto-Sonic drilling and 6" continuous sampling from 29.5' to 77.0' on 8/30/99.	

BORING LOG

MW-10


PAGE 2 OF 4

DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 6 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
32.0'-37.0' silty CLAY, dark gray with some subangular to subrounded gravel - dry (medium dense)		35					
(37.0')							
37.0'-40.0' Fine SAND, gray with a trace of silt and gravel - dry (medium dense)		40					
(40.0')							
40.0'-48.0' SILT, dark gray with a trace of gravel - dry (very dense)		45					
(48.0')							
48.0'-60.0' CLAY, dark gray and dark brown with a trace of coarse sand - moist (medium to very dense)		50					
(60.0')							
60.0'-62.0' Fine SAND, gray with a trace of silt - moist (Loose)		60					
(62.0')							
62.0'-66.0' SILT, dark gray with 4" Fine sand lenses - moist (very dense)		65					
(66.0')							
66.0'-68.0' Fine SAND, dark gray with a trace of silt and gravel - moist (Loose)							
(68.0')							
68.0'-70.0' SILT, dark gray with some subangular to subrounded gravel - dry (medium to very dense)		70					
(70.0')							

BORING LOG

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MW-10

DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 6 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
70.0'-77.0' SILT, dark gray with a trace of subrounded to subangular gravel - moist (medium to very dense)		75					Continuous Roto-Se sampling and drilling. From 77.0' to 129.5' on 8/31/99.
(77.0')		80					
77.0'-93.0' SILT, dark gray with a trace of gravel and intermittent clay and fine sand lenses - moist (medium to very dense)		85					
(93.0')		90					
93.0'-98.0' silty CLAY, dark gray with a trace of subrounded to subangular gravel - dry (very dense)		95					
(98.0')		100					
98.0'-102.0' CLAY, glauconitic with brown sandy clay lenses - moist (loose)		105					
(102.0')							
102.0'-110.0' CLAY, light brown with a trace of silt and gravel - dry (medium to very dense)							

BORING LOG

W. W. - 10

PAGE 4 OF 4

DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 6 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
(110.0') 110.0 - 120.0' SILT, gray to dark gray with a trace of gravel - dry (very dense)		110					
(120.0') 120.0' - 123.0' CLAY, dark gray with a trace of fine sand and gravel - dry (medium dense)		115					
(123.0') 123.0' - 129.5' Fine to coarse sandy CLAY, dark gray with a trace of gravel - moist (medium dense)		120					
(129.5') Boring terminated at 129.5'		125					
		130					Per work plan cease Auto-sonic sampling and drilling at 130.0 on 8/31/99 at 1540h. Recovered sample to 129 Boring is dry. Boring sealed/filled to surface with a 95% cement/ 5% bentonite grout on 8/31/99.
							8" borehole with 95/5% grout

BORING LOG

PAGE 1 OF 4

PROJECT NUMBER: 98-478-03	PROJECT NAME: RML - Beach Grove
BORING / WELL NUMBER: MW-20	LOCATION: Beach Grove Indiana
DIAMETER: 4"	WATER DEPTH: 1st Water @ 21.75'
GEOLOGIST: Eric Stank	COMPLETION DEPTH: Well E.O.D. @ 31.0'
DRILLING METHOD: HSA and Roto-Sonic	SAMPLING METHOD: HSA/SS & Roto-Sonic
DRILLING SUBCONTRACTOR: Goert Longway	DEVELOPMENT METHOD: Surge block/prop
	DATE/TIME: 8/12/99 20920
	DATE STARTED: 8/12/99
	DATE COMPLETED: 8/21/99
	YIELD: ~ 3 gpm

DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 8 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
0.0-1.5' Asphalt (4.5") stone and rubble (1.5')							
1.5-4.0' CLAY, gray with a trace of silt and gravel - moist (Loose) (4.0')							
4.0-7.0' CLAY, black, gray and brown with some silt - moist (Loose to medium dense) (7.0')							
7.0-7.25' GRAVEL, Limestone with some silt (Loose) (7.25')							
7.25-12.0' CLAY, Light brown and gray with a trace of silt - moist (medium dense) (12.0')							
12.0-15.5' CLAY, Light brown with some silt and a trace of fine sand and subangular to subrounded gravel - moist (medium dense) (15.5')							
15.5-16.0' Limestone cobbles (16.0')							
16.0-21.75' S<, tan with some fine sand and a trace of coarse sand - moist (Loose) (21.75')							
21.75-22.0' Fine SAND, brown - wet (Loose) (22.0')							
22.0-25.0' Grades from material at 21.75' to very fine SAND with silt - moist (Loose) (25.0')							
25.0-26.25' S<, dark brown with a trace of clay and subangular to subrounded gravel - moist (medium dense) (26.25')							
26.25-27.0' Fine SAND, Light brown with some silt and a trace of gravel - wet (Loose) (27.0')							
27.0-31.0' S<, dark brown with a trace of clay and gravel - dry (very dense) (31.0')							
31.0-49.0' S<, dark brown and dark gray with a trace of subangular to subrounded gravel -							

On 8/12/99 use 6 1/4" HSA and split spoon sampling to determine what depth to overdrive with 12" augers and set 8" surface casing. Set 8" surface to 31.0' on 8/12/99. Grout casing in on 8/12/99.

Surface casing Set to 31.0'. Begin 8" Roto-Sonic drilling and 6" Roto-Sonic completion.

BORING LOG

MW-2A

PAGE 2 OF 4

DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 6 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
dry (medium to very dense)		35					Sampling from 31.0' to 110.0' on 8/21/99.
		40					
		45					
(49.6')							
49.6'-50.0' Fine sandy CLAY, dark gray and black with a trace of gravel - moist (medium dense)		50					
50.0'-56.0' CLAY, dark gray with a trace of fine sand - moist (medium dense)							
(56.0')		55					
56.0'-58.0' CLAY, glauconitic with a trace of gray fine sand and silt - moist (medium dense)							
(58.0')							
58.0'-60.0' SILT, gray and tan mottled with some clay and a trace of fine sand and gravel - moist (medium to very dense)		60					
(60.0')							
60.0'-68.0' Fine sandy SILT with a trace of gravel - moist (loose to medium dense)							
(68.0')		65					
68.0'-80.0' Coarse SAND, black and gray with gravel and intermittent very fine sand lenses - wet (very loose)		70					

BORING LOG

MW-20

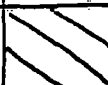






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DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 6 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
		75					
(80.0')		80					
80.0'-84.0' silty medium SAND, gray with a trace of gravel - moist (loose)							
(84.0')		85					
84.0'-90.5' very fine SAND, gray - moist (loose)							
(90.5')		90					
90.5'-96.0' SILT, dark gray with a trace of gravel - dry (medium to very dense)							
(96.0')		95					
96.0'-99.0' silty CLAY, brown and gray mottled - dry (medium dense)							
(99.0')		100					
99.0'-110.0' SILT, dark gray with a trace of gravel - dry (very dense)							
		105					

BORING LOG

MW-20

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DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 6 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
Boring terminated at 110.0'		110					Per conversation w Project biologist & Roto-Sonic sampling drilling at 110.0' on 8/21/91. Build back boring to 80.0' & begin well construc- tion at 80.0'.
							8" borehole 15/5 to grow and 11" dia PVC casing
							8" borehole bentonite 4" diameter PVC casing
							8" borehole #5 sand and diameter PVC casing
							8" borehole #5 sand and slot 4" dia PVC casing
							8" borehole with bent
							8" borehole with #5 sand

BORING LOG

PAGE 1 OF 4

PROJECT NUMBER: 98-478-03		PROJECT NAME: RML - Beech Grove			
BORING / WELL NUMBER: MW-30		LOCATION: Beech Grove Indiana			
DIAMETER: No well installed.		WATER DEPTH: 1st water @ 13.75'		DATE/TIME: 8/11/99	
GEOLOGIST: Eric Stucke		COMPLETION DEPTH: 130'		DATE STARTED: 8/11/99	
DRILLING METHOD: HSA and Roto-Sonic		SAMPLING METHOD: HSA/SS & Roto-Sonic		DATE COMPLETED: 8/20/99	
DRILLING SUBCONTRACTOR: Goert Longyear		DEVELOPMENT METHOD: Not Applicable		YIELD: Not Applicable	

DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 6 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
0.0'-1.0' SILT, tan with trace organics - dry (1.0')							<p>On 8/11/99 use 6" HSA and split spoon sampling to determine what depth to overdrill with 10" augers and set 8" surface casing. Set 8" surface casing to 32' on 8/11/99. Grout casing in on 8/12/99.</p> <p>Surface casing set to 32.0' on 8/12/99.</p>
1.0'-2.0' SILT, gray and brown mottled with trace rock fragments - dry (2.0')							
2.0'-6.0' SILT, brown and tan mottled with trace of subrounded to rounded gravel - dry (6.0')							
6.0'-8.5' Fine sandy CLAY, light brown and tan with a trace of subrounded gravel - dry (8.5')							
8.5'-10.25' silty fine SAND, with trace of subrounded to rounded gravel - moist (10.25')							
10.25'-13.0' CLAY, brown with trace of fine to coarse sand - moist (13.0')							
13.0'-13.75' SILT, gray - dry (13.75')							
13.75'-14.0' SAND, gray medium to coarse with trace clay - wet (14.0')							
14.0'-19.5' CLAY, gray with some subangular to rounded gravel - moist and medium dense (19.5')							
19.5'-20.0' silty fine SAND, with trace of subrounded to rounded gravel - moist (20.0')							
20.0'-21.5' subangular to rounded gravelly SILT, gray and wet (21.5')							
21.5'-24.5' SILT, gray with some subrounded to rounded gravel - moist (24.5')							
24.5'-25.0' fine to coarse SAND - dry (25.0')							
25.0'-26.0' SILT, gray - dry (26.0')							
26.0'-26.5' clayey fine SAND, medium dense (26.5')							
26.5'-27.5' clayey SILT, gray with trace of rounded to subrounded gravel - dry (medium dense) (27.5')							
27.5'-29.0' CLAY, brown with trace of fine sand (medium to very dense) - moist (29.0')							
29.0'-32.0' CLAY, gray with trace gravel and silt - dry (very dense) (32.0')							
32.0'-35.0' clayey SILT, gray with trace of							

BORING LOG

MW-32

PAGE 2 OF 1

DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 6 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
Subrounded gravel - dry (very dense) (35.0')		35					Drilling and 6" Auto- Sonic Continuous sam- pling From 32.0' to 55.0' on 8/18/99.
35.0'-37.0' SILT, gray with trace clay and subangular to subrounded gravel to 1" in diameter - moist (loose) (37.0')							
37.0'-42.0' SILT, gray with some subrounded to rounded gravel - dry (medium to very dense) (42.0')		40					
42.0'-45.0' SILT, gray - dry (very dense) (45.0')		45					
45.0'-48.0' medium SAND, gray and black - wet grades to medium to coarse SAND, gray and black with some gravel - wet (very loose) (48.0')							
48.0'-52.0' SILT, gray to black - dry (very dense) (52.0')		50					Continuous Auto-Sonic Sampling and Drilling From 55.0' to 117.0' on 9/19/99.
52.0'-54.5' glauconitic CLAY, mixed with fine sand and gravel - dry (medium to very dense) (54.5')		55					
54.5'-59.0' CLAY, light brown with some fine sand and a trace of gravel - moist (loose to medium dense) (59.0')							
59.0'-60.0' SILT, gray interbedded with light brown sand (medium dense) (60.0')		60					
60.0'-64.0' SAND, light brown with a trace of silt and gravel - dry (medium dense) (64.0')							
64.0'-66.0' SILT, dark gray to gray with a trace clay and gravel - dry (medium dense) (66.0')		65					
66.0'-69.0' CLAY and fine SAND, light brown and gray - dry (medium dense) (69.0')							
69.0'-70.0' coarse SAND, gray and black with some gravel and a trace of silt (loose) (70.0')		70					

BORING LOG

MW-30

PAGE 3 OF

DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 6 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
70.0'-79.0' SILT, gray with a trace of gravel - dry (medium to very dense)		75					
(77.0')		80					
79.0'-80.0' SILT, gray with some gravel - wet (loose)							
80.0'-81.0' gravelly SILT, gray to dark gray - wet (loose)							
(81.0')		85					
81.0'-85.0' SILT interbedded with SAND, both gray. Silt has some clay - dry (medium dense). Sand is medium to coarse with a trace of gravel (medium dense).							
(85.0')		90					
85.0'-90.0' SILT, gray with a trace of sub-angular to sub rounded gravel - dry (medium dense)							
(90.0')		95					
90.0'-90.5' Fine to coarse SAND, gray - wet (loose)							
(90.5')		100					
90.5'-98.0' silty CLAY, gray with a trace of sub angular to sub rounded gravel - dry (medium to very dense)							
(98.0')		105					
98.0'-105.0' CLAY, light brown and light gray mottled with a trace of silt and gravel - dry (medium to very dense)							
(105.0')							
105.0'-114.5' clayey SILT, light brown with a trace of gravel - dry (medium dense)							

BORING LOG

MW-30

PAGE 4 OF 4

DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 6 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
		110					
(114.5')		115					
114.5'-127.0' Fine sandy SILT, gray-dry (very dense) (tree branch at 115.0')		120					Continuous Auto-Son sampling and drilling from 117.0' to 130.0' on 8/20/99.
		125					
(127.0')							
127.0'-130.0' very fine SAND, gray-moist (medium to very dense)		130					
(130.0')							
Boring terminated at 130.0' per work plan.							Per work plan close Auto-Sonic sampler and drilling at 130.0' on 8/20/99 at 0910h. Boring is dry. Boring sealed/filled to surf with a 95% cement- 5% bentonite grout on 8/20/99.
							9" borehole 95/5% grout

BORING LOG

PAGE 1 OF 4

PROJECT NUMBER: 98-478-03		PROJECT NAME: RML - Beech Grove					
BORING / WELL NUMBER: MW-60		LOCATION: Beech Grove Indiana					
DIAMETER: 4"		WATER DEPTH: 26.0'			DATE/TIME: 8/12/99 1100		
GEOLOGIST: Eric Stanke		COMPLETION DEPTH: 123.0'			DATE STARTED: 8/12/99		
DRILLING METHOD: HSA and Roto-Sonic		SAMPLING METHOD: HSA/SS & Roto-Sonic			DATE COMPLETED: 8/18/99		
DRILLING SUBCONTRACTOR: Boert Longyear		DEVELOPMENT METHOD: Surge block & pump			YIELD: ~ 2 gpm		
DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 6 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
0.0'-10.0' See MW-6s log.		5					On 8/12/99 use data from MW-6s to auger without sampling to 10.0'. HSA/SS from 10.0' to 19.0'. On 8/14/99 over drill hole with 10" augers and set 8" casing to 19.0'.
(10.0') 10.0'-14.0' CLAY, dark brown and tan mottled with some subrounded gravel and a trace of fine sand - moist (Loose)		10					
(14.0') 14.0'-16.0' silty CLAY, dark brown and brown mottled with some subrounded gravel - moist (medium dense)		15					
(16.0') 16.0'-19.0' SILT, dark gray with a trace of sub-rounded gravel - moist (medium dense)		20					
(19.0') 19.0'-24.0' Fine SAND, gray with a trace of silt and angular gravel and intermittent c/s thick clay lenses - moist (Loose)		25					
(24.0') 24.0'-26.0' silty CLAY, brown and gray mottled with a trace of fine sand and subangular to subrounded gravel - moist (medium dense)		30					Surface casing set to 9.0'. Begin 8" Roto-Sonic driven and 6" Roto-Sonic continuous sampling from 19.0' to 105.0' on 8/17/99.
(26.0') 26.0'-28.0' Fine to coarse SAND, brown with a trace of silt & some gravel - moist (medium dense)							
(28.0') 28.0'-28.5' silty CLAY, gray with a trace of fine sand and subrounded gravel - dry (medium dense)							
(28.5') 28.5'-29.0' Fine to coarse SAND - moist (Loose)							
(29.0') 29.0'-30.0' silty CLAY, gray with a trace of fine sand - dry (medium dense)							
(30.0') 30.0'-44.0' CLAY, gray with some subangular to sub-rounded gravel - dry (medium to very dense)							

BORING LOG

mw-67


PAGE 2 OF 4

DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 6 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
		35					
		40					
		45					
(44.0') 44.0'-46.0' clayey GRAVEL, gray subangular to rounded - wet (loose)							
(46.0') 46.0'-47.0' CLAY, gray with some subangular to subrounded gravel - dry (medium to very dense)							
(47.0') 47.0'-50.0' fine SAND to Gravel, poorly sorted gray - wet (very loose)							
(50.0') 50.0'-58.0' CLAY, glauconitic with a trace of rounded gravel - dry (very dense)							
(58.0') 58.0'-60.0' fine SAND, brown with some silt and a trace of gravel grades to fine SAND, brown with a trace of silt and gravel - wet (loose)							
(60.0') 60.0'-62.0' fine sandy SILT, light brown with a trace of subangular to subrounded gravel - dry (medium dense)							
(62.0') 62.0'-72.0' SILT, light brown with a trace of clay, subrounded gravel and fine sand - dry (medium dense)							
		65					
		70					

BORING LOG

M.L. 60








PAGE 3 OF 4

DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 6 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
(72.0') 72.0'-82.0' Fine SAND, light brown to dark gray with a trace of silt and gravel - moist (Loose)		75					
(82.0') 82.0'-85.0' SILT, dark gray with some fine sand and gravel - moist (Loose)		80					
(85.0') 85.0'-90.5' Fine SAND, dark brown to dark gray - moist (Loose)		85					
(90.5') 90.5'-96.0' Fine to coarse SAND, dark gray with some gravel and a trace of silt - moist (Loose)		90					
(96.0') 96.0'-99.0' Fine SAND, gray to dark gray with a trace of silt and gravel - moist (Loose)		95					
(99.0') 99.0'-108.0' CLAY, gray with some gravel and a trace of silt - dry (medium to very dense)		100					
		105					
							Continuous Air-Son Sampling and Drilling 105.0' to 123.0' on 8/18/79

BORING LOG

m-60

PAGE 4 OF 6

DESCRIPTION	WELL CONSTRUCTION	DEPTH (FT.)	PENETRATION BLOWS PER 6 IN.	RECOVERY (FT.)	INSTRUMENT READING	SAMPLE NUMBER	REMARKS
<p>(108.0')</p> <p>108.0'-123.0' silty CLAY, dark gray to gray with a trace of gravel <3" diameter -dry (medium to very dense)</p>		110					
		115					
		120					
<p>(123.0')</p> <p>Boring terminated at 123.0'</p>		125					<p>Per conversation with Project Geologic Geose Rotasonic and drilling at 123 on 8/18/99. Build b to 96.0' and begin re construction at 96.</p>
		130					<p> 8" borehole 75/5% gravel and 4" diam PVC casing</p>
							<p> 8" borehole bentonite & 4" diam PVC casing</p>
							<p> 8" borehole #5 sand and diameter of casing</p>
							<p> 8" borehole #5 sand and slot diam PVC casing</p>
							<p> 8" borehole with #5 Sand</p>

LOG OF TEST BORING

TEST BORING MW-11

DATE: 9/9/03

PROJECT: RMC Beech Grove

BORING LOCATION: Beech Grove, Indiana

DRILLING METHOD: 6-1/4" Hollow Stem Auger

DRILLING COMPANY: Boart Longyear

WATER ENCOUNTERED AT:

PROJECT NO.: 2003-1046

SURFACE ELEVATION:

CHECKED BY: PGS

DRILLER: Dan

INSPECTOR: S. Wiswall

ELEVATION / DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS BLOWS PER 6 INCHES	Soil Description	SPT (N)	Moisture (%)	Other Tests
0		0-5' Topsoil, leaves.	0 0		
5	8/6 19/6 42/6 36/6	5-7' Very stiff to hard tan-brown silty clay with occasional fine gravel, dry.	5.0 -5	78	
10	10/6 12/6 48/6 15/6	10-12' Very stiff tan-brown silty clay with occasional fine gravel, subangular to rounded, moist.	10.0 -10	63	
15	10/6 24/6 10/6 17/6 12/6 17/6 34/6 25/6	15-17' Stiff brown silty clay, moist.	15 -15	27	
		16-16.5' Medium dense, fine to coarse sand, poorly sorted, subangular to rounded upwardly fining, saturated.	16.0 -16 17.0 -17	59	
20	15/6 19/6 20/6 23/6	19-20' Very stiff to hard gray to brown silty clay, medium dense, fine silty sand, rounded upwardly, fining, saturated.	19.0 -19		
		21-23' Very stiff brown silty clay with occasional fine gravel, dry.	21.0 -21	43	
		22.4-22.8' Medium dense gray fine to medium sand, well sorted, saturated.	22.4 -22.4 22.8 -22.8		
25		22.8-23' Very stiff gray clay.			
30		END OF BORING	30 -30		
35					

LOG OF TEST BORING

TEST BORING MW-10

DATE: 9/9/03

PROJECT: RMC Beech Grove

BORING LOCATION: Beech Grove, Indiana

DRILLING METHOD: 6-1/4" Hollow Stem Auger

DRILLING COMPANY: Boart Longyear

WATER ENCOUNTERED AT:

PROJECT NO.: 2003-1046

SURFACE ELEVATION:

CHECKED BY: PGS

DRILLER: Dan

INSPECTOR: S. Wiswall

ELEVATION / DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS BLOWS PER 6 INCHES	Soil Description	SPT (N)	Moisture (%)	Other Tests
0		0-5' Topsoil, some root mat.	0 0		
5	5/6 8/6 12/6 12/6	5-7' Stiff tan-brown to gray silty clay (CL) with frequent subangular to rounded fine gravel, dry to moist.	5.0 -5	24	
10	7/6 34/6 45/6 25/6	10-12' Medium stiff to stiff brown silty clay (CL), dry to moist.	10.0 -10	70	
15	15/6 17/6 43/6 46/6	12-15' Fine to coarse gravel with some clay, silt, poorly sorted subangular to rounded, saturated.	12.0 -12		
15	15/6 17/6 43/6 46/6	15-17' Very stiff brown silty clay, moist.	15.0 -15	89	
20	10/6 20/6 25/6 26/6	17-19' Hard gray silty clay with frequent fine gravel, subangular to rounded.	17.0 -17	51	
20	10/6 23/6 27/6 30/6	19-21' Very stiff to hard gray silty clay with fine gravel, moist.	19.0 -19	57	
25					
30					
35					
		END OF BORING	36.0 -36		



APPENDIX B

**QUALITY ASSURANCE PROJECT PLAN
FOR GROUNDWATER MONITORING
AT
REFINED METALS CORPORATION SITE
U.S. EPA ID NUMBER IND000718130**

Prepared For:

**REFINED METALS CORPORATION
Beech Grove, Indiana**

Prepared By:

**ADVANCED GEOSERVICES CORP.
West Chester, Pennsylvania**

**Project No. 2003-1046-00
August 6, 2004**



APPENDIX B

QUALITY ASSURANCE PROJECT PLAN FOR GROUNDWATER MONITORING AT REFINED METALS CORPORATION SITE U.S. EPA ID NUMBER IND000718130

Prepared For:

**REFINED METALS CORPORATION
Beech Grove, Indiana**

Prepared By:

**ADVANCED GEOSERVICES CORP.
West Chester, Pennsylvania**

**Project No. 2003-1046-00
August 6, 2004**



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Groundwater Monitoring QAPP
Revision 1: August 2004
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List of Persons Who Have Received This QAPP

**AGC
Refined Metals Corporation
Indiana DEM
U.S. EPA Region 5**



1.0 PROJECT DESCRIPTION

1.1 INTRODUCTION

On behalf of Refined Metals Corporation (RMC) Advanced GeoServices Corp. (AGC) has prepared this Quality Assurance Project Plan (QAPP) for the proposed groundwater monitoring activities at the RMC Facility in Beech Grove, Indiana (Site). This QAPP breaks out those portions of the EPA-approved QAPP appended to the RFI Work Plan dated March 3, 1999 that address groundwater monitoring. Except for the addition of analytical parameters and sampling events, no substantive changes have been made to the QAPP elements applicable to groundwater sampling. This QAPP contains a statement of the Data Quality Objectives (DQO), Sampling and Analysis Procedures, Quality Assurance/Quality Control Procedures, and Data Quality Analysis (DQA). A Health and Safety Plan (HASP) is provided as Appendix B.

1.2 QAPP PREPARATION GUIDELINES

This QAPP has been prepared in accordance with the Region 5 QAPP policy as presented in U.S. EPA RCRA QAPP Instructions, dated April 1998 and the Indiana Department of Environmental Management Risk Integrated System of Closure (RISC) dated February 2001.

1.3 OVERALL PROJECT OBJECTIVES AND DECISION STATEMENTS

Overall objectives of the data collection will be as follows:

- Define the presence, magnitude, extent, and mobility of hazardous waste and hazardous waste constituents in groundwater beneath the former site area and



adjacent off-site areas that may have originated from the RCRA permitted hazardous waste or solid waste management units at the Site.

The groundwater sampling program outlined in the Sampling and Analysis Plan for Groundwater Monitoring (SAP) and the principles and procedures set forth in this QAPP are designed to ensure that data are of sufficient quality to perform comparisons with target decision levels and evaluate impact from permitted RCRA units at the facility. The Decision Statement for this investigation is as follows: identify the nature and extent of RCRA metals and select volatile organic compounds (VOCs) in groundwater attributable to historic RCRA units that present unacceptable risks, which would therefore warrant remedial action.

1.4 SITE/FACILITY DESCRIPTION

1.4.1 Location

The Refined Metals Corporation Site is located at 3700 Arlington Avenue, Beech Grove, Marion County, Indiana, in a zone of mixed land uses.

1.4.2 Facility/Site Size and Borders

The Site encompasses approximately 24 acres, and is bordered by a railroad spur on the north, a Firestone facility that manufactures roofing materials on the east (across Arlington Avenue), and a mix of vacant and industrial properties to the south. A Citizens Gas Storage facility and pipeline are located northwest of the Site, and a railroad yard and repair facility and Conrail and Amtrak are located beyond Citizens Gas toward the northwest.



1.4.3 Natural and Manmade Features

Section 3.0 of the RFI Work Plan discusses natural features on and surrounding the Site, and Section 2.0 of the RFI Work Plan describes the manmade features of the facility.

1.4.4 Topography

See Section 3.2 and Figure 3-1 of the RFI Work Plan for information concerning the Site topography and drainage.

1.4.5 Local Geology and Hydrogeology

See Sections 3.4 and 3.5 of the RFI Work Plan for information concerning the regional and local geology and hydrogeology of the Site.

1.4.6 Surrounding Land Use

See Section 3.3 of the RFI Work Plan for a discussion on surrounding land use.

1.4.7 Ecological Communities and Habitats

See Section 3.6 of the RFI Work Plan for a discussion of the ecological setting as determined through a site visit.



1.5 SITE/FACILITY HISTORY

1.5.1 General History

Refined Metals Corporation was engaged in recycling lead batteries and other lead wastes. There are currently no manufacturing operations at the facility. The plant was constructed in 1968 as a secondary lead smelter. In 1984, a battery breaker operation was installed. From April 14, 1995, through December 31, 1995, operations were reduced to enriching and casting lead ingots from off-specification lead products.

The facility was constructed to recycle lead batteries and other lead wastes. Automotive batteries constituted 90 percent of the materials recycled, and the remainder was waste material from battery manufacturers and other lead scrap. During operation, the batteries were temporarily stored in trailers or on pallets in a paved storage yard. The batteries were then fed into the battery crusher, where the tops of the batteries were sawed off and the sulfuric acid was drained into a stainless steel tank that drained to the wastewater treatment system. The battery casings and their contents were tumbled and crushed. Lead plates and other lead parts were separated and transported to the materials storage building to be later placed in the furnace. The battery casings were shredded and separated into plastic and rubber in a flotation tank. The plastic was blown into a trailer for sale to be sold to an off-site recycler. Rubber was stored and then fed into the blast furnace.

Before 1984, materials were stored on-site with minimal spill or runoff control. Storm water runoff from the storage piles and work areas flowed to the storage pond and evaporated; some runoff flowed off site to the north drainage ditch. Once the battery crusher was installed in 1984, a batch neutralization system was installed to treat acidic wastewater from the battery crushing and flotation



systems. The wastewater was neutralized before discharging to Beech Grove Municipal Sanitary Sewer system. Since 1988, all stormwater has been contained and routed to the wastewater treatment system.

Reportedly, underground storage tanks (USTs) were never used at the Site. Three above ground storage tanks (ASTs) - two 10,000-gallon (ASTs) and one 20,000-gallon AST - were used to store diesel fuel for company trucks. The tanks were reportedly cleaned out in 1985 and are out of service. The three tanks are enclosed by a spill containment wall which was reportedly constructed before 1980. A 500-gallon AST and a 750-gallon AST were used for diesel fuel and gasoline, respectively, to fuel on-site vehicles. The 750-gallon gasoline tank is enclosed within a spill containment wall and pad. Propane, which is used to power forklifts, is stored in a 2,000-gallon tank.

A leak in a valve of one of the out-of-service diesel tanks occurred around 1983, resulting in a spill outside of the containment wall. A portion of the spill flowed along the drainage ditch located north of the refining area. The contaminated soil was excavated and the tanks were emptied. Although documentation of the spill is not available, the soil cleanup was reportedly conducted under state supervision.

1.5.2 Past Data Collection Activities

Low levels of lead and arsenic have been detected in unfiltered groundwater samples (and on one occasion a filtered sample that is believed to be a discrepancy) collected from the Site. Prior data has been used as a screening tool to assist RMC in developing the proposed groundwater monitoring plan; however, prior data will not be used to determine risk to human health or ecological receptors.



1.5.3 Current Status

Since 1996, no production has taken place and the facility has been inactive.

1.6 PROJECT OBJECTIVES AND INTENDED DATA USAGES

For the purpose of groundwater monitoring it will be necessary to gather sufficient information to evaluate the nature and extent of releases from solid waste management units, and also to determine whether unreasonable risks to human receptors are associated with groundwater impacts.

The groundwater monitoring activities will consist of:

- Low-flow groundwater sampling using the existing shallow groundwater monitoring well network.

Data collection activities will specifically address the following concerns:

- The nature and extent of groundwater contamination; and,
- The impact of potential groundwater contamination on human health.

Parameters listed in Table 1-1 are the proposed critical measurement parameters for this project.

AGC risk assessment staff have reviewed the media sampling programs as proposed in the Groundwater Monitoring Plan and this QAPP to ensure that data collection activities will be in accordance with USEPA guidance for data quality objectives (USEPA 1987a,b).



1.6.1 Project Target Parameters

Based on past sampling data and as stated in the Consent Decree, the primary constituents of concern at the Site are lead and cadmium. Groundwater samples will be analyzed for metals (antimony, arsenic, iron, lead, manganese, and sodium), chloride, and sulfate. The iron, manganese, sodium, chloride, and sulfate will be analyzed for the first four quarters only. Groundwater samples collected during Phase I of the RFI were analyzed for certain VOCs, including tetrachloroethylene (PCE), 1,1,1-trichloroethane (TCA), benzene, toluene, and ethylbenzene. No VOCs were detected; therefore, no further analysis is required in subsequent groundwater sampling events. Sampling parameters and quantitation limits are listed on Table 1-1.

1.6.2 Field Parameters

Low-flow sampling indicator parameters such as temperature, pH, redox potential, dissolved oxygen, turbidity, and specific conductance will be monitored in the field during well purging (for monitoring wells) and at the time of sample acquisition to assure that the well has been adequately purged and that the groundwater is a representative sample from the aquifer.

1.7 SAMPLING LOCATIONS

Groundwater sampling will be performed in the three shallow groundwater monitoring wells already present at the Site plus one additional shallow groundwater monitoring well proposed in the SAP. A figure showing the location of existing and proposed wells is provided in the SAP.



1.8 PROJECT SCHEDULE

Groundwater sampling will be performed for four consecutive quarters. Thereafter groundwater sampling will be performed semi-annually until closure of the permitted RCRA units. In addition, the parameters for analysis after the first four quarters will be reduced to only those parameter shown to represent a statistically significant influence from the permitted RCRA units.



2.0 PROJECT ORGANIZATION AND RESPONSIBILITY

2.1 PROJECT ORGANIZATION CHART

The Refined Metals Corporation has selected Advanced GeoServices Corp., West Chester, Pennsylvania to be responsible for coordinating sampling and analysis activities and validating data received from the laboratory. TriMatrix Laboratories, Grand Rapids, Michigan, will conduct the chemical analyses of the samples. This laboratory possesses all credentials to do this work; qualifications and standard operating procedures were provided as Attachments to the RFI Work Plan QAPP.

While all personnel involved in the investigation and in the generation of data are implicitly a part of the overall project and quality assurance program, certain individuals have specific responsibilities. The key individuals who are responsible for the overall coordination of efforts to be conducted, as well as the collection, validation and interpretation of the data generated during this project, are identified in the following sections.

2.2 MANAGEMENT RESPONSIBILITIES

2.2.1 IDEM

Project Manager - Ruth Jean



Responsibilities of the IDEM Project Manager include:

- Overseeing implementation of the administrative order;
- Providing technical review and approval of all plans and data submitted as part of this investigation; and
- Coordinating site monitoring activities with RMC Project Manager

2.2.2 Refined Metals Corporation

Project Manager – Matthew Love

Responsibilities of RMC Project Manager include:

- Providing historical information regarding facility operations and processes.
- Preparing and submitting monthly updates on project progresses and other relevant information as required by the Consent Decree.
- Overseeing and coordinating all project activities on behalf of RMC.
- Reviewing and approving contract related issues, including scope of work, and approving invoices for payment.
- Reviewing and commenting on technical reports.
- Representing RMC at meetings with IDEM.
- Approving changes in the scope and direction of investigations and other technical issues.



2.2.3 Advanced GeoServices Corp.

Project Manager - Paul G. Stratman, P.E., P.G.

Responsibilities of the AGC Project Manager include:

- Managing and coordinating site monitoring;
- Reviewing information;
- Initiating any SAP or QAPP modifications;
- Providing in-house technical support for evaluating and organizing field data; and
- Providing input to the Task Managers on technical direction.

Task Manager - E. Terry Jensen

Responsibilities of the AGC Task Manager include:

- Managing and coordinating the tasks of the Investigator and technical staff personnel;
and,
- Reviewing information obtained during the groundwater sampling.

2.3 QUALITY ASSURANCE RESPONSIBILITIES

2.3.1 Advanced GeoServices Corp.

Quality Assurance (QA) Manager - Jennifer Stanhope



Responsibilities of the AGC QA Manager include:

- Performing data validation and assessment of the analytical data generated during sampling;
- Communicating analytical deficiencies found during data validation to the Project and Task Managers to initiate corrective action;
- Preparing data validation reports and tabulation of analytical data;
- Communicating with the laboratory for data deliverables and any problems with the data reported; and,

In addition, AGC Quality Assurance Scientists will be utilized to review chain-of-custodies, validate data, construct data summary tables, and perform data entry. The QA Scientists will report to the QA Manager.

2.4 LABORATORY RESPONSIBILITIES

2.4.1 TriMatrix Laboratories, Inc.

Laboratory Operations Manager

The Laboratory Operations Manager's responsibilities include:

- Liaison with sampling firm's Project Manager, Quality Assurance Manager, and laboratory technical staff;
- Production and efficiency of all departments including QA/QC;
- Recommendations of appropriate corrective action procedures to the QA Manager;
- Identification and supervision of appropriate and necessary support personnel; and



- Oversees final analytical results.

Laboratory Program Manager

The responsibilities of the Laboratory Program Manager include:

- Coordinates laboratory analyses;
- Supervises in-house chain-of-custody;
- Oversees data review and data assessment;
- Oversees preparation of analytical reports; and
- Approves final analytical reports prior to submittal to the Client.

Laboratory Quality Assurance Supervisor (LQAS)

Responsibilities of the LQAS include:

- Oversees QA/QC documentation;
- Inspecting and verifying laboratory QA/QC records and results;
- Implementing all laboratory QA/QC procedures contained in the QAPP;
- Overseeing corrective actions as required; and
- Conducting internal system and performance audits and inspection of analytical procedures.



Laboratory Sample Custodian

The Sample Custodian's responsibilities include:

- Providing sample bottles;
- Receiving and inspecting the incoming sample bottles;
- Recording the condition of the incoming sample containers;
- Verifying chain-of-custody and it's correctness;
- Notifying Laboratory Program Manager of sample receipt and inspection;
- Assigning an unique identification number and customer number and enters each into the sample receiving log; and
- Controlling and monitoring access/storage of samples.

Laboratory Technical Staff

The technical staff will be responsible for sample analysis and identification of corrective actions.

The staff will report directly to the Laboratory Program Manager.

2.5 FIELD RESPONSIBILITIES

2.5.1 Advanced GeoServices, Corp.

On-Site Principle Investigator (PI)



The PI's responsibilities include:

- Providing full time field representation during field data collection activities;
- Collecting and reporting raw data; and,
- Overseeing any site contractors and other field personnel to ensure adherence to the SAP and QAPP.

Ensuring the appropriate QC samples are collected.

Field Technical Staff

The technical staff for this project will be drawn from AGC's pool of corporate resources. The technical staff will be utilized to gather and analyze data, and to prepare various task reports and support materials. All of the designated technical team members are experienced professionals who possess the degree of specialization and technical competence required to effectively and efficiently perform the required work.



3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

Data Quality Objectives (DQOs) are quantitative and qualitative statements specifying the quality of the environmental data required to support the decision making process. Separate DQOs are designed for field sampling and laboratory analysis so that clear distinctions between any problems found in the system can be isolated with respect to cause. Conversely, the DQOs are also designed to provide an indication of the variability of the overall system. The overall quality assurance objective is to keep the total uncertainty within an acceptable range that will not hinder the intended use of the data and to provide results which are legally defensible in a court of law. To achieve this, specific data requirements such as detection limits, criteria for precision and accuracy, sample representativeness, data comparability and data completeness (PARCC) are specified below. The DQOs for the RMC Site are presented in Tables 3-1 and 3-2.

3.1 PRECISION

3.1.1 Definition

Precision is a measure of the degree to which two or more measurements are in agreement.

3.1.2 Field Precision Objectives

Field precision is assessed through the collection and measurement of field duplicates at a rate of 1 duplicate per 10 analytical samples. The total number of duplicates for this project is found in Table 3-3 of this QAPP.



3.1.3 Laboratory Precision Objectives

Precision in the laboratory is assessed through the calculation of relative percent differences (RPD) and relative standard deviations (RSD) for three or more replicate samples. The equations to be used for precision in this project can be found in Section 12.2 of this QAPP. Precision control limits are provided in Table 3-2.

For inorganic analyses, laboratory precision shall be assessed through the analysis of a matrix spike and field duplicate pairs. All parameters of concern listed in Table 1-1 of this QAPP are included in method spiking solutions for MS analyses.

3.2 ACCURACY

3.2.1 Definition

Accuracy is defined as the degree of agreement of a measurement or average of measurements with an accepted reference value. Accuracy measures the bias in a measurement system which may result from sampling or analytical error. Sources of error that may contribute to poor accuracy are:

- laboratory error;
- sampling inconsistency;
- field and/or laboratory contamination;
- handling;
- matrix interference; and
- preservation.



3.2.2 Field Accuracy Objectives

Accuracy in the field is assessed through the use of field and trip blanks and through the adherence to all sample handling, preservation and holding times.

3.2.3 Laboratory Accuracy Objectives

Laboratory accuracy is assessed through the analysis of MS, laboratory control samples (LCS), and the determination of percent recoveries. Accuracy in laboratory methods and procedures will be evaluated by use of calibration and calibration verification procedures, and instrument performance solutions at the frequency specified in the USEPA "Test Methods for Evaluating Solid Waste Physical/Chemical Methods", April 1998, SW-846 5th edition (SW-846). The equation to be used for accuracy in this project can be found in Section 12.1 of this QAPP and "Methods of Chemical Analysis of Water and Wastes" March 1983. Accuracy control limits are given in Table 3-2. All parameters of concern included in Table 1-1 of this QAPP are included in method spiking solutions for the LCS and MS samples.

3.3 DATA COMPLETENESS

3.3.1 Definition

Completeness is defined as the percentage of data that is judged to be valid to achieve the objectives of the investigation compared to the total amount of data.



3.3.2 Field Completeness Objectives

Field completeness is a measure of the amount of valid measurements taken in the project. The equation for completeness is presented in Section 12.3 of this QAPP. The field completeness objective for this project will be greater than 90 percent.

3.3.3 Laboratory Completeness Objectives

Laboratory completeness is a measure of the amount of valid measurements obtained from all measurements taken in the project. The equation for completeness is presented in Section 12.3 of this QAPP. The laboratory completeness objective for this project, with respect to critical measurement parameters identified in Table 1-1, will be greater than 90 percent.

3.4 DATA REPRESENTATIVENESS

3.4.1 Definition

Representativeness expresses the degree to which sample data represent the characteristics of the environment from which they are collected. Samples that are considered representative are properly collected to accurately characterize the contamination at a sample location.

3.4.2 Measures to Ensure Representativeness of Field Data

Representativeness is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the SAP is followed and that proper sampling techniques are used. Representativeness will be measured by using the field methods (e.g., sampling, handling, and



preserving) in accordance with NEIC Policies and Procedures Manual and analytical methods in accordance with SW-846 methodologies.

3.4.3 Measures to Ensure Representatives of Laboratory Data

Representativeness in the laboratory is ensured by using the proper analytical procedures, appropriate methods, meeting sample holding times and analyzing and assessing field duplicate samples. The sampling network was designed to provide data representative of facility conditions. During development of this network, consideration was given to past waste disposal practices, the physical setting, and hydrogeologic conditions at the Site.

3.5 DECISION RULES

3.5.1 Definition

A Decision Rule is a statement which allows for a course of action or non-action to be taken, based on assumptions made to draw out and test its logical or empirical consequences.

3.5.2 Decision Rule Objectives

The decision rule objectives for this investigation address the definition of statistical parameter(s) characterizing the population, identification of action levels, and development of if/then statements defining conditions that would cause the decision maker to choose among alternate actions. The decision rule associated with groundwater monitoring is that if any of the critical measurement parameters listed in Table 1-1 are identified above human health levels in any of the monitoring wells, then the data will be used to define the extent of contamination or map the plume boundaries.



The decision rule will be applied to validated data obtained from SAP and RFI sampling activities with the following conditions:

- Sampling of the groundwater will not be performed until specific field parameters (i.e. redox potential, pH, specific conductance and dissolved oxygen) stabilize.

The decision rule will be used following the validation of SAP data and the requirements for a baseline human health assessment and preliminary ecological risk assessment will be determined at that time.

3.6 COMPARABILITY

3.6.1 Definition

Comparability expresses the confidence with which one data set can be compared with another data set from a different phase or from a different program.

3.6.2 Measures to Ensure Comparability of Field Data

Comparability is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the SAP is followed and that proper sampling techniques are used.

3.6.3 Measures to Ensure Comparability of Laboratory Data

Comparability will be accomplished by ensuring that proper sample collection techniques will be utilized and through the use of standardized and approved methods of analysis.



3.7 LEVEL OF QUALITY CONTROL EFFORT

PARCC parameters will be monitored through the submission and analyses of various types of field and laboratory QC samples. These will include appropriate field blanks, equipment blanks, laboratory method blanks, field duplicates, matrix spikes, instrument performance solutions, and a careful examination of all calibration and check standards. Specifically:

- Field blanks and equipment blank consisting of distilled water will be submitted to the laboratory to provide the means to assess the quality of the data resulting from the field sampling program.
- Field blank samples are analyzed to check the procedural contamination at the facility which may cause sample contamination.
- Equipment blank samples are analyzed to check the decontamination procedural for field equipment which may attribute to cross contamination.
- Method blank samples are generated within the laboratory and used to assess contamination resulting from laboratory practices.
- Duplicate samples are analyzed to check for sampling and analytical reproducibility.
- MS are performed to provide information about the effect of the sample matrix on the digestion and measurement methodology.
- Instrument performance solutions, calibration and check standards are analyzed to assess the capability of the laboratory to perform the specific methods.

The frequency by which the field and laboratory QC samples will be prepared and submitted is specified in Section 8.0 of this QAPP. Table 3-3 summarizes the type and frequency of QC samples to be performed during this investigation. Sampling procedures for blanks and field duplicates are provided in Section 8.1.1 and 8.1.2. Quantitation limits for the critical measurement parameters are provided in Table 3-4.



4.0 SAMPLING PROCEDURES

Groundwater sampling is required to monitor the presence/absence and degree of metal constituents in groundwater at the Site. Specific sampling procedures are set forth in this section to meet the QA objectives outlined in Section 3.0 of this QAPP. The SAP must be used concurrently with this QAPP during field sampling. SOPs are provided for the following RFI activities:

- Groundwater sampling;
- Field equipment decontamination; and,
- Sample handling.

4.1 GROUNDWATER SAMPLING

Groundwater sampling events will be conducted at four on-site monitoring wells.

4.1.1 Sampling Procedures

Detailed sampling procedures are provided in SOPs in Attachment B and include:

- Low-flow pump purging and sampling; and,
- Field parameter measurements.

Samples will be collected directly from the low-flow pump discharge line into laboratory provided sample containers or dedicated disposable filter units and then into laboratory prepared bottles (for dissolved metal analyses). Field parameter analyses will include, temperature, pH, specific conductance, redox potential, dissolved oxygen and turbidity, which will be measured using flow-through cells during well purging to determine if the well was adequately purged prior to sample



collection. Field blanks, equipment blanks, field duplicates, and matrix spike samples will be obtained as described in Section 8.1.

4.1.2 Sample Designation/Identification

Each sample will be assigned a sample designation according to a pre-determined numbering system. The sample designation at a minimum will include in abbreviated form: type of sample (i.e., MW) and a sample number. The sample designation will be written in indelible ink on an identification labels/tags and attached to the sample container. Sample labels/tags will also contain the items noted in Section 5.1.2.

4.1.3 Analytical Parameters

All samples collected will be analyzed for the parameters listed on Table 4-1. Table 4-1 lists the associated analytical methods, sample preservatives, sample container requirements, and holding times.

4.2 FIELD EQUIPMENT DECONTAMINATION

To prevent possible contamination from sampling equipment, all non-dedicated sampling devices will be decontaminated. Non-dedicated equipment is the low flow pump. Sampling equipment will be constructed of inert material (e.g., stainless steel, Teflon®). For non-dedicated equipment, field decontamination will be performed prior to its initial use, between sampling locations and between actual samples when more than one sample is to be collected at a given location. Decontamination is not required when dedicated equipment is used. All decontamination and subsequent use of decontaminated equipment will be documented in a field logbook.



All non-dedicated sampling equipment will be decontaminated according to the following procedure:

1. Wash equipment thoroughly with a low phosphate detergent (Alconox) and water using a brush to remove any particulate matter or surface film.
2. Rinse equipment with distilled water.
3. Rinse with diluted nitric acid (10% N).
4. Triple rinse with distilled water.
5. Air dry equipment.
6. Wrap equipment in a clean plastic sleeve or in aluminum foil if not used immediately.

Spent nitric acid will be contained in a bucket and placed in drums.

4.3 SAMPLE HANDLING

4.3.1 Sample Containers

Sample containers will be provided to the sampling team by the laboratory sample custodian. All sample containers used in the course of this investigation will be new containers, pre-cleaned and certified as Level II or higher by I- CHEM Inc. Certificates of analysis are available from I-CHEM upon request. All bottles will be prepared by the laboratory with the appropriate preservative. After sample collection, containers will be labeled as specified in Section 5.1.2.



4.6.2 Sample Preservation and Holding Times

The laboratory will provide appropriately prepared sample containers for this project. The sample containers will be I-Chem bottles or the equivalent which are cleaned and preserved for the specific analysis. Aqueous samples for metals analyses will be preserved with nitric acid to pH<2. Samples for dissolved metals will be field filtered prior to preservation. All samples will be placed on ice and maintained at a temperature of approximately 4 degrees Celsius from the time of collection to the time of analysis.

The metals have a holding time limit of six months. Chloride and sulfate have a holding time limit of 28 days.



5.0 CUSTODY PROCEDURES

A sample is physical evidence collected from the project site. Due to the evidential nature of the data generated from sampling, sample custody must be traceable from the time the empty sample containers are prepared by the container supplier through the reporting of the results of the analyses. As an essential part of project management, sample control procedures have been established to ensure sample integrity. All sample containers and samples will be maintained under strict custody procedures throughout the investigation. Sample custody is addressed in three parts: field sample collection, laboratory analysis and final evidence files.

A sample, sample container, or evidence file will be considered under custody if:

- the item is in actual possession of a person; or
- the item is in the view of the person, after being in actual possession of the person; or
- the item was in the person's actual physical possession but is now locked up or sealed in a tamper-proof manner; or
- the item is placed in a designated secured restricted area.

5.1 FIELD CUSTODY PROCEDURES

Sample custody for samples collected during this investigation will be maintained by the field personnel collecting the samples. The field personnel are responsible for documenting each sample transfer and maintaining custody of all samples until they are shipped to the laboratory or archived.



5.1.1 Field Data Documentation/Field Logs

A system of logging all pertinent data collected during sampling operations will be maintained using dedicated bound field logbooks. Each page will be numbered, dated and initialed by the person making the entry. All entries will be made in indelible ink. Incorrect entries will be crossed out with a single line and verified with the recorder's initials. At the completion of the day, if a page is not complete, a diagonal line will be drawn through the remainder of the page with the notetaker's signature at the bottom.

All sample locations will be recorded and referenced to the site map so that each location is permanently established. Samples will be tagged with all pertinent site information at the time of sampling. Section 5.1.2 describes sample identification. Pertinent site information to be supplied in the field logbook for each task is listed below:

- Signature of notetaker;
- Name and location of investigation;
- Date and time of arrival and departure;
- Names of all personnel on-site and their affiliation;
- Purpose of the visit/description of field activity;
- All field instruments used, date and time of calibration and calibration checks, method of calibration, standards used;
- All field measurement results;
- Date, time, and location of all sampling points;



- Method of sample collection;
- Any factors which could affect sample integrity;
- Name of sampler;
- Sample identification, sample description, sample preservation;
- Documentation of all conversations with the client, agency personnel, field decisions and approval; and
- Weather conditions.

Field logbooks should contain only factual information entered as real-time notes which will enable the user to recreate events on-site. They are a part of the project file and are admissible as evidence in litigation. In addition, chain-of-custody records will be prepared and kept as part of the field records.

5.1.2 Sample Identification

All sample bottles will be identified by the use of sample labels or tags with sample identification. Each sample will be labeled by the sampler to avoid any possibility of sample misidentification. Indelible ink shall be used to complete sample labels/tags. Each sample label/tag will be labeled at the time of collection with, at a minimum, the following information:

- Site specific project number and name;
- Date and time (military) of sample collection;



- Sample designation (location), note here if the sample is a QC sample or to be used for QC analysis;
- Whether sample is a grab or composite;
- Presence of a preservative;
- Field representative(s) collecting the sample (Sampler); and
- Analyses requested.

The field sampler will maintain custody of samples following the procedures outlined in the following section until samples are properly relinquished to the laboratory or to a common carrier for delivery to the laboratory. Once at the laboratory, each sample will be assigned a unique laboratory identification number that will be used for analysis assignment, sample tracking, and data reporting while the samples are at the laboratory.

5.1.3 Chain-of-Custody Procedures

The following chain-of-custody procedures will be used for this project:

- New, certified clean sample containers will be prepared and relinquished by the laboratory on a chain-of-custody record. The chain-of-custody record will be used for all samples collected to document the sample custody transfer from person to person.
- Any transfer of custody of containers or samples will be noted on the chain-of-custody record.
- Each sample collected for the project will be entered on the chain-of-custody record.



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- The chain-of-custody will be completed as soon as possible after sample collection. The following information must be supplied to complete the chain-of-custody record:
 - a. Site specific project name and number;
 - b. Signature of samplers;
 - c. For each sample, sampling station number, date and time (military) of collection, grab or composite sample designation, and brief description of the type of sample and sampling location;
 - d. Number of sample containers per each sample location;
 - e. Analysis required;
 - f. Type of sample preservative;
 - g. Signatures of individuals involved in sample transfer (i.e., relinquishing and accepting samples). Individuals receiving the samples shall sign, date, and note the time that they received the sample on the record; and
 - h. Type of carrier service.
- The original chain-of-custody record will accompany the sample containers during transport to document their custody.
- If custody is relinquished through a common parcel carrier for delivery to the laboratory, the following protocol will be followed:
 - a. The original completed chain-of-custody record will be placed inside the shipping package; and
 - b. The shipping package will be sealed with tape and custody seals affixed. The seals will be placed on the package in such a manner that the package cannot be opened without breaking the seals. The seals will serve to document that the shipping container was not opened during the shipment through the common parcel carrier.



The chain-of-custody record is presented on Figure 5-1 of this QAPP.

5.1.4 Sample Shipment Procedures

At the end of the sampling day, all samples for chemical analysis will be packaged in shipping containers for shipment to the analytical laboratory using the following steps:

1. Check each sample bottle for a properly completed sample identification label.
2. Place sample bottles from each location in separate plastic bags, then seal.
3. Ship the samples in a large capacity (waterproof metal or equivalent strength plastic) cooler, or specific laboratory-prepared sample shipping container. Place packing material (asbestos-free vermiculite, perlite, or Styrofoam beads) on the bottom of the cooler to prevent sample bottle breakage.
4. Place sample bottles in the shipping container in a manner that they do not touch and will not touch during shipment. Secure with packing material as needed to fill void space.
5. Maintain all samples at approximately 4°C during shipment. Use ice or freezer packs to cool the samples.
6. Place the original chain-of-custody record in a plastic bag, seal, and tape it to the inside of the shipping container lid.
7. Retain the pink copy of the chain-of-custody for the QA Manager.
8. Tape cooler drain shut. Tape the cooler or shipping container closed at a minimum of two locations.
9. Place two signed and dated custody seals across each edge of the shipping container.



10. Attach completed shipping label to the top of the cooler.
11. Relinquish the cooler to the courier with the required signed and dated handbill.
12. Retain receipt of the handbill as part of the permanent documentation.

If the sample coolers are not shipped but instead picked up by the laboratory courier, step number 6 and 12 will be omitted and the chain-of-custody will be handed to and signed by the laboratory courier. The pink copy of the chain-of-custody will be maintained by the sampler and presented to the AGC QA Manager.

5.2 LABORATORY CUSTODY PROCEDURES

Laboratory custody procedure are outlined in Attachment B of the QAPP contained in the RFI Work Plan (dated March 1999), Laboratory Chain-of-Custody Standard Operating Procedure. Once the sample arrives at the laboratory, custody of the samples will be maintained by laboratory personnel. Upon receipt of the samples, the sample custody personnel will remove the chain-of-custody from the sealed cooler and sign and record the date and time on the chain-of-custody. The samples received will be verified to match those listed on the chain-of-custody. The laboratory will document and notify the Sampling Contractor's QA Manager immediately if any inconsistencies exist in the paperwork associated with the samples. The laboratory at a minimum will document the following stages of analysis: sample receipt, sample extraction/preparation, sample analysis, data reduction, and data reporting.



Samples will be given an unique laboratory identification number which is entered into the sample receiving log and the Laboratory Information Management System (LIMS). The analyst will enter the analytical data into the LIMS upon analysis completion and validation. The samples are placed into appropriate storage (refrigerators at 4°C) within an access controlled location. All samples are maintained under proper storage conditions for thirty days past the generation of the analytical report. The LIMS tracks the sample until completion of the report and invoice mailing. The data archived from the LIMS will be transferred to magnetic tape and retained for five years from the completion of sample analysis.

A chain-of-custody Sample Control Record is used as the documentation for the movement of chain-of-custody samples in and out of the access controlled storage. The analyst signs sample in and out each time a sample(s) is removed for any analysis. After all analyses are complete, the sample custodian files the form in the chain-of-custody project file. An example of the chain-of-custody Sample Control Record can be found on Figure 5-2.

Procedures for the custody of analytical data are outlined in Section 4.1, Attachment A. Sample disposal procedures are outlined in Section 4.2.4, Attachment A.

5.3 FINAL EVIDENCE FILES

The final evidence file will be a central repository for all documents which constitute evidence relevant to sampling and analysis activities as described in this QAPP. AGC is the custodian of the evidence file and maintains the contents of evident files for the investigation at the AGC West Chester office. The files will be maintained as mandated by the EPA and will be maintained for a



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minimum six years after the termination of the order. The final evidence file will contain at a minimum the following:

- Field logbooks;
- Photographs;
- Drawings;
- Laboratory data deliverables;
- Data validation reports;
- Progress reports; and
- Custody documentation.



6.0 CALIBRATION PROCEDURES AND FREQUENCY

In order to provide high quality data, it is essential for all field and laboratory equipment to be in satisfactory operating condition. Thus, routine equipment calibration and maintenance is required.

6.1 FIELD INSTRUMENT CALIBRATION

During groundwater sampling, field measurements including pH, temperature, redox potential, dissolved oxygen, specific conductance and turbidity will be taken. Field calibration procedures, at a minimum, will include the following:

- Calibration of field instruments will be performed by trained technicians prior to mobilization of equipment to the site. All instruments will be calibrated as specified by the manufacturer. Standard solutions will also be checked to determine stability and operating conditions. All results of field calibrations and measurements will be maintained in bound site-dedicated logbooks assigned to the specific instrument and/or field logbooks at least daily when the instrument is in use. The recorded calibration information will include date and time of calibration, standards used, corrective actions taken if necessary, and calibration results. Routine field equipment maintenance will be documented in bound logbooks which will be kept with the field instruments.
- pH meters will be calibrated according to manufacturer's instructions prior to each use and will, at a minimum, consist of two standard buffer solutions (4, 7, or 10) obtained from chemical supply houses. Additionally, two standard buffer solutions will be analyzed as verification checks after every 20 samples and after each use. The verification check results must agree within ± 0.05 pH standard units or recalibration and reanalysis of all samples since the last verification check sample is required.



- All field thermometers will be checked against a NIST or equivalent thermometer once a year. The temperature difference will be documented in a logbook and the field measurements will be adjusted accordingly. Temperature measurements will be recorded to $\pm 0.2^{\circ}\text{C}$.
- Dissolved oxygen meters are calibrated by a trained technician prior to use in the field using a 100 percent relative humidity chamber (air calibration method). A Winkler titration is performed to check the accuracy of the air calibration method. Dissolved oxygen meters will be calibrated in the field daily by the sampling personnel using the air calibration method.
- Specific conductance meters will be calibrated prior to each use using two potassium chloride solutions prepared by a qualified laboratory or chemical supplier. These solutions will bracket the levels of the samples. At a minimum, one of the solutions will be analyzed as a verification check after each sample location and at the end of the day. The verification check must be within $\pm 10\%$ of the true value. If the verification check is not within 10% of the true value, recalibration of the instrument is required and the last sample must be reanalyzed.
- Turbidity meters will be calibrated daily prior to use by using a standard of known turbidity provided by the manufacturer.

All calibration procedures performed will be documented in the field logbook and will include the date and time of calibration, name of the person performing the calibration, reference standards used, and the instrument readings.

6.2 LABORATORY INSTRUMENT CALIBRATION

Calibration procedures for a specific laboratory instrument will consist of initial calibrations, initial calibration verifications and continuing calibration verification. The SOP for each analysis performed in the laboratory describes the calibration procedures, their frequency, acceptance criteria and the conditions that will require recalibration. In all cases, the initial calibration will be verified



using an independently prepared calibration verification solution. Specific laboratory instrument calibration requirements summarized in Table 6-1 outlined in Section 13.0 of each applicable laboratory SOP provided in Attachment B of the RFI Work Plan.

The laboratory maintains a sample logbook for each instrument. These logbooks contain the following information: instrument identification, date of calibration, analyst, calibration standards, and samples associated with these calibrations.

If equipment fails calibration or equipment malfunction is noted during calibration, the equipment is tagged and removed from service. The equipment is held out of service until repairs and successful calibration occur. All malfunctions, repairs and recalibrations are recorded in the appropriate instrument maintenance and calibration logs.



7.0 ANALYTICAL PROCEDURES

7.1 FIELD ANALYTICAL PROCEDURES

Temperature, redox potential, dissolved oxygen, turbidity, pH and specific conductance measurements of samples will be performed to determine if a well has been adequately purged. All field measurements will be collected according to manufacturer's instructions. Table 3-2 presents the quality control requirements and criteria for the field measurement parameters.

7.2 LABORATORY ANALYTICAL PROCEDURES

All sample media will be analyzed by TriMatrix Laboratories, Inc. TriMatrix is located at:

5560 Corporate Exchange Court SE
Grand Rapids, Michigan 49512
Telephone (616) 975-4500
Facsimile (616) 942-7463

The laboratory will conduct the analyses in accordance with the specified methods in Table 7-1. Only the most updated U.S. EPA methodology will be used. These methods have been selected because they are deemed sufficient to achieve the project data quality objectives. Standard Operating Procedures for the analyses are identified in Table 7-1 and are provided as attachments to the RFI Work Plan. These SOPs for sample preparation and analysis are based on the applicable USEPA Method. These SOPs provide sufficient detail and are specific to this investigation.



The laboratory SOPs listed in Table 7-1 include a QA section which address the minimum QC requirements for analyses. All quality control samples identified in Section 8.0 will be analyzed as appropriate for each method. The quality control criteria as identified in the referenced U.S. EPA methods must be met or appropriate action will be taken. This may include termination of analysis, reanalysis of samples, or accepting the data and acknowledging a level of uncertainty.

7.2.1 Project Target Compounds and Laboratory Detection Limits

A complete listing of the project target analytes, quantitation limits and laboratory method detection limits is provided in Table 3-4.

7.2.2 List of Associated Quality Control Samples

Section 13.0 of the laboratory SOPs listed in Table 7-1 specifies the minimum QC requirements for the analysis of specific analyte groups. All project target analytes will be added to the spiking solution, in compliance with project requirements. Section 8.0 of this QAPP contains a complete listing of the associated QC samples for every analyte group and matrix.



8.0 INTERNAL QUALITY CONTROL CHECKS

Quality control and quality assurance procedures include both field and laboratory check samples and are designed to ensure and document the overall quality of the data. QA/QC checks detect potential problems at the source and, if necessary, trace the sample analytical pathways for introduction of contamination. The quality control data generated in the field will monitor sampling techniques, reproducibility, and cleanliness. Quality control data generated by the laboratory will monitor reproducibility (precision), cleanliness, and accuracy in analyzed samples. During data validation, QC check results are used to evaluate precision, accuracy, and representativeness of the overall sampling and analytical program.

8.1 FIELD QUALITY CONTROL CHECKS

The field quality control samples monitor the data quality as it is affected by the field procedures and conditions. Field QC samples are control samples that are introduced to the laboratory from the field. During field sampling efforts, different types of QA samples will be collected: field blanks, equipment blanks, field replicate and samples, matrix spike samples. The QC criteria for each field quality control sample are provided in Table 3-2. Validation guidelines outlined in Section 9.2 will be used for the acceptance limits of the field QC samples. Each type of QA sample is described below.

8.1.1 Field Blanks

Field blanks are collected in the field by pouring demonstrated analyte-free water provided from the laboratory from one sample container into a preserved sample container identical to those provided



for sample collection. One field blank will be collected for each sampling round, and will be analyzed for the same parameters as the actual samples. Field blanks for dissolved metals will be filtered through a 0.45 μm filter prior to preservation.

8.1.2 Equipment Blanks

Equipment blanks are prepared in the field to ensure a sampling device (e.g., pump) has been effectively cleaned. The sampling equipment is filled with deionized water or deionized water is pumped through the device, transferred to the laboratory supplied sample bottles, preserved if necessary, and sent to the laboratory for analyses with the site samples. If dedicated equipment is not used, one equipment blank will be submitted for analyses for every 10 samples per media collected, and will be analyzed for the same parameters as the field samples. Equipment blanks for dissolved metals will be filtered through a 0.45 μm filter prior to preservation.

8.1.3 Field Duplicate Samples

Field duplicate samples consist of an actual sample taken in the field which has been split into two aliquots and put into two separate sampling containers. Aqueous samples will be obtained by alternately filling sample containers from the same sampling device for each parameter. The samples will be transported to the laboratory and analyzed as two separate samples. The results will be used to assess laboratory accuracy and precision of sampling and analysis.



Each sample will be labeled with a unique sample number and submitted to the laboratory for the appropriate analyses. Field duplicate samples determine analytical precision and sample representativeness. One field duplicate sample will be collected for every 10 samples per media collected.

8.1.4 Matrix Spike

Matrix spike (MS) samples will be submitted in association with metal analyses as further QC checks. MS will be collected from the same location as the field sample and in the same manner.

Each sample will be labeled with the sample number as the original sample, designated on the chain-of-custody as MS, and submitted to the laboratory for the appropriate analyses. MS samples determine accuracy by the recovery rates of the compounds added by the laboratory (all site related metal compounds will be included in the spiking solution). The MS samples also monitor any possible matrix effects specific to samples collected from the site and the extraction/digestion efficiency. One MS sample will be collected for every 20 samples per media collected and analyzed.

8.2 LABORATORY QUALITY CONTROL CHECKS

All QC procedures employed by the laboratory will be, at a minimum, equivalent to those required in the specified analytical methods. Laboratory QC checks are accomplished through the analyses of laboratory blanks, matrix spike, calibration verifications, laboratory fortified blanks and performance evaluation samples. When internal quality control results fall outside method acceptance criteria, the data will be reported, and the analysis repeated, flagged or accepted according to the specified analytical methods. The following sections generally describe internal



laboratory quality control check samples. Quality control requirements are outlined in Section 18 of the laboratory SOPs contained in the RFI Work Plan QAPP.

8.2.1 Laboratory Blanks

Method/preparation blanks are generated within the laboratory during the processing of the actual samples. These blanks will be prepared using the same reagents and procedures and at the same time as the project samples are being analyzed. If contamination is found in the method blank, it indicates that similar contamination found in associated samples may have been introduced in the laboratory and not actually present in the samples themselves. Guidelines for accepting or rejecting data based on the level of contamination found in the blank are presented in the specified analytical method and laboratory SOPs.

A minimum of one method blank per 20 samples will be analyzed or, in the event that an analytical round consists of less than 20 samples, one method blank sample will be analyzed.

8.2.2 Instrument Blanks

Instrument blanks are prepared by the laboratory using deionized water for sample analysis. Instrument blanks are analyzed every ten samples to verify no cross contamination or baseline drifting has occurred. An instrument blank is generally analyzed after each calibration verification standard.



8.2.3 Matrix Spike

Matrix spike analyses are performed in association with the sample metal analyses. Matrix spikes are prepared by placing a known quantity of selected target analytes into a second aliquot of an actual field sample. All project target analytes will be included in the spiking solution. The spiking occurs prior to sample preparation and analysis. The matrix spike is then processed in a manner identical to the field sample. Recovery of each of the spiked compounds reflects the ability of the laboratory and method to accurately determine the quantity of that compound in that particular sample.

Matrix spike will be analyzed at a frequency of one pair per sample delivery group of up to 20 samples collected.

8.2.4 Calibration Verifications

Initial calibration of the instruments will be completed prior to sample analysis following the specified analytical methods and laboratory SOPs. Additionally, continuing calibration standards will be analyzed at least every tenth sample. Recalibration is required if the continuing calibration standards do not meet U.S. EPA method criteria. Specific calibration standard procedures are outlined in the laboratory Standard Operating Procedures (Attachment B of the RFI Work Plan).

8.2.5 Laboratory Control Sample (LCS)

The LCS is prepared by the laboratory by adding analytes of known concentrations to DI water for aqueous metals analysis. Reference materials with known concentrations are digested concurrent with samples for solid metals analyses. The LCS is designed to assess the capability of the



laboratory to perform the analytical methods. If the analytes present in the LCS are not recovered within the criteria defined in the specified analytical methods, the samples will be redigested and reanalyzed or data will be flagged.

8.2.6 Performance Evaluation Samples

Performance testing evaluation (PT) samples are of known composition which has been provided to the laboratory for analysis by either an agency or client. The laboratory results are compared to the actual values to evaluate the laboratory's performance. Performance evaluation sample analyses are performed on a regular basis as required for the laboratory's certifications. Some PT programs which TriMatrix participates in are USEPA Water Pollution Performance Evaluation Study, ASI National Performance Evaluation Study and USEPA Water Supply Study.



9.0 DATA REDUCTION, VALIDATION AND REPORTING

9.1 DATA REDUCTION

9.1.1 Field Data Reduction Procedures

All field data will be written in ink into bound field logbooks immediately after measurements are taken. If errors are made, the error will be crossed out with a single line, initialed and dated with the corrections written clearly adjacent to the original entry.

9.1.2 Laboratory Data Reduction Procedures

All analytical data will be permanent, complete and retrievable. The analyst will record the analytical data in notebooks along with other pertinent information such as the laboratory ID number. Each page of the notebook shall be signed and dated by the analyst. Periodic review of the notebooks will be performed by a supervisor prior to final data reporting. Upon analysis completion and laboratory validation, the analyst will enter the analytical data into the LIMS.

The laboratory will report sample results on analysis report forms and provide the information described in USEPA SW-846 for all analyses for each package. A CLP-like data deliverables package is required. All laboratory data will undergo the data validation procedures described in the Laboratory QA Manual prior to final reporting. Data will be stored on the laboratory's network until the investigation is complete. Data archived from the LIMS will be transferred to magnetic tape which will be retained by the laboratory an additional five years, minimum.



The equations that will be employed in reducing data are presented in Section 16 of the associated SOPs. The formulas included in the SOP make pertinent allowances for sample matrices. All calculations are checked by a second person prior to data entry into the LIMS. All groundwater metals results will be reported in micrograms per liter ($\mu\text{g/L}$) or milligrams per liter (mg/L). All blank results and QC data will be included in the data deliverables/package. Blank results will not be subtracted from the sample results. The blank results and QC data will be used in data validation to review sample results qualitatively. Data validation will be performed in general accordance with the guidelines identified in Section 9.2. Outliers and other questionable data will be addressed in the data validation report and specific QA/QC flags will be applied to questionable data. The QA/QC flags will be consistent with the USEPA data validation guidelines.

9.2 DATA VALIDATION

9.2.1 Procedures Used to Validate Field Data

Validation of the field data will be performed by the field technicians under the supervision of the QA manager. One hundred percent of the field analytical data will be validated. The procedures to validate the field data for this investigation include checking for transcription errors and review of logbook, on part of the field crew members. This task will be the responsibility of the lead field technician.



9.2.2 Procedures Used to Validate Laboratory Data

Validation of analytical data as received from the laboratory will be performed by the AGC QA Manager or QA Scientist. Validation will be performed on 100% of the analytical data in general accordance with the following data validation guidance document, where applicable: USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, Office of Emergency and Remedial Response, USEPA, Washington, D.C. July 2002 and IDEM Guidance to the Performance and Presentation of Analytical Chemistry Data (July 1998). The Data Management Plan, provided as Attachment C of the RFI Work Plan, discusses the specific procedures for the validation of CLP data. Quality control requirements specified in the methods will also be used to evaluate the data. Specific data validation procedures are outlined in Tables 9-1 through 9-3. Validation criteria are not met for any parameter, the associated samples will be qualified as indicated in Table 9-1.

The following presents definitions for the validation qualifiers:

- U - The analyte was analyzed for, but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection limit.
- J - The associated value is an estimated quantity.
- R - The data are unusable. (Note: The analyte may or may not be present.)
- UJ - The analyte was analyzed for, but was not detected. The associated detection limit is an estimate and may be inaccurate or imprecise.



The purpose of data validation is to assess the usability of the data by determining if the laboratory analyses met the PARCC criteria set by the site DQO's, the analytical method used and the guidance documents. Upon completion of data validation, the existing results will be reported in tabular form with data validation flags applied as appropriate to determine the usefulness of the data. The data validation flags will be consistent with the USEPA and IDEM data validation guidelines. A data validation report will be written to assist in making decisions based on the analytical results.

9.3 DATA REPORTING

Data validation reports, along with copies of all support documentation, validated data summary tables, and analytical data packages, will be submitted electronically and as a hard copy monthly to RMC Project Manager as data is validated as required by IDEM. The RMC Project Manager will forward to the IDEM, after adequate time for review, all documents, data and reports. The data validation report will be prepared.

9.3.1 Field Data Reporting

Field data reporting will be conducted through the transmission of logbook sheets containing tabulated results of all measurements made in the field, and documentation of all field activities.

9.3.2 Laboratory Data Reporting

The task of reporting laboratory data begins after the independent validation activity has been concluded. The AGC Quality Assurance Manager must perform a final review of the report



summaries and case narratives to determine whether the report meets project requirements. In addition to the record of chain-of-custody, the report format shall consist of the following:

1. Case Narrative:
 - i. Date of issuance
 - ii. Laboratory analysis performed
 - iii. Any deviations from intended analytical strategy
 - iv. Laboratory batch number
 - v. Numbers of samples and respective matrices
 - vi. QC procedures utilized and also references to the acceptance criteria
 - vii. Laboratory report contents
 - viii. Project name and number
 - ix. Condition of samples 'as-received'
 - x. Discussion of whether or not sample holding times were met
 - xi. Discussion of technical problems or other observations which may have created analytical difficulties
 - xii. Discussion of any laboratory QC checks which failed to meet project criteria
 - xiii. Signature of the Laboratory QA Manager
2. Chemistry Data Package:
 - i. Case narrative for each analyzed batch of samples



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- ii. Summary page indicating dates of analyses for samples and laboratory QC checks
- iii. Cross referencing of laboratory sample to project sample identification numbers
- iv. Description of data qualifiers to be used
- v. Sample preparation and analyses for samples
- vi. Sample results
- vii. Raw data for sample results and laboratory QC samples
- viii. Results of (dated) initial and continuing calibration checks
- ix. MS recoveries, laboratory control samples, method blank results, and calibration check compounds
- x. Labeled (and dated) instrument data of sample results and laboratory QC checks
- xi. Copies of Nonconformance Reports

The data package submitted will be a "CLP-like" data package consisting of all the information presented in a CLP data package (but without the CLP forms).

All deliverables/packages from each laboratory must be paginated in ascending order. The laboratory must keep a copy of the paginated package in order to be able to respond efficiently to data validation inquiries. Any errors in reporting identified during the data validation process must be corrected by the laboratory as requested. All data validation inquiries to the laboratory must be addressed by a written response from the laboratory in question.



The deliverables will be provided to the AGC Quality Assurance Manager and will be made available to the EPA upon request.

9.4 DATA ACQUISITION REQUIREMENTS AND DATA QUALITY MANAGEMENT

Once the samples are collected and sent to the laboratory, the field sampler will send a copy of the chain-of-custody and field notes to the AGC Quality Assurance Manager. The chain-of-custodies will be checked for the appropriate analytical methods defined, parameters requested, number of samples collected and QC samples collected. The laboratory will be contacted if any information on the chain-of-custody is missing or incorrect. The CLP-like deliverables hard copy and electronic data will be provide to the AGC QA Manager. The QA Manager will perform an initial check to verify that all the samples were analyzed, the correct methods were used for analyses, all requested parameters were analyzed and samples were analyzed within the holding time requirements. The electronic deliverables will be downloaded into a site specific database and checked with the hard copy deliverables during the data validation process. A project status form will be completed each time a check level is performed. The project status form and check forms are included in Attachment D of the RFI Work Plan.

Analytical data, reports, and any other project related information produced during this project will be retained by AGC or its designee. Project reports, tables, etc. may be stored in project specific electronic files. On a regular basis, the data will be backed up on magnetic tapes and stored off-site. The files will be maintained as mandated by the EPA and will be maintained for a minimum six years after the termination of the order.



10.0 PERFORMANCE AND SYSTEM AUDITS AND FREQUENCY

Performance and system audits will be conducted to verify that sampling and analysis are performed in accordance with the procedures established in this QAPP.

10.1 FIELD PERFORMANCE AND SYSTEM AUDITS

10.1.1 Internal Audits

10.1.1.1 Internal Audit Responsibilities

Internal audits of field activities including sampling and field measurements will be conducted by the AGC QA Manager. These audits will verify that all established procedures are being followed.

10.1.1.2 Internal Audit Procedures

The audits will include a review of field sampling records, field screening analytical results, field instrument operating records, sample collection, handling and packaging in compliance with the established procedures, and maintenance of QA procedures, chain-of-custody, etc. by the AGC QA Manager in the AGC office at the completion of the round of sampling under the SAP. Follow-up discussion will be conducted with the field samplers to correct any deficiencies and to verify that QA procedures are maintained during subsequent sampling.



10.1.2 External Field Audits

10.1.2.1 **External Field Audit Responsibilities**

External field audits may be conducted by the IDEM.

10.1.2.2 **External Field Audit Frequency**

External field audits may be conducted any time during the field operations. These audits may or may not be announced and are at the discretion of IDEM.

10.1.2.3 **External Field Audit Process**

External field audits will be conducted according to the field activity information presented in the QAPP. The external field audit process can include (but not be limited to): sampling equipment decontamination procedures, sample bottle preparation procedures, sampling procedures, examination of field sampling and safety plans, sample vessel cleanliness and QA procedures, procedures for verification of field duplicates, sample preservation and preparation for shipment, as well as field screening practices.



11.0 PREVENTATIVE MAINTENANCE

11.1 FIELD INSTRUMENT PREVENTATIVE MAINTENANCE

Field measurement equipment, pH meters, thermometers, dissolved oxygen meters, and specific conductance meters will be maintained in accordance with manufacturer's instructions. All field equipment will be checked by qualified technicians prior to use in the field. The instrument operator will be responsible for ensuring that the equipment is operating properly prior to use in the field. Any problems encountered while operating the instrument will be documented in the field logbook. Critical spare parts such as batteries and pH probes will be kept on-site to reduce potential downtime. If problem equipment is detected or should require service, the equipment will be returned and a qualified technician will perform the maintenance required. Use of the instrument will not be resumed until the problem is resolved. Backup instruments and equipment will be available on-site or within 1 day shipment to avoid delays in the field activities. Routine maintenance of field instruments will be documented in bound logbooks which will be kept with the field instrument. Spare parts and the maintenance schedule are presented on Table 11-1.

11.2 LABORATORY INSTRUMENT PREVENTATIVE MAINTENANCE

Preventative maintenance and periodic maintenance is performed as recommended by the manufacturers of the equipment in use in the laboratory. Spare parts are kept in inventory to allow for minor maintenance.

The laboratory staff performs preventive maintenance and repairs or coordinates with a vendor for the repair of all instruments. All laboratory instruments are maintained in accordance with



manufacturer's specifications and the requirements of the specific method employed. This maintenance is carried out on a regular, scheduled basis and is documented in the laboratory instrument service logbook for each instrument. Emergency repair or scheduled manufacturer's maintenance is provided under a repair and maintenance contract with factory representatives. The following Table 11-1 summarizes preventive maintenance schedules and critical spare parts inventories. Refer to the SOPs included in Attachment B of the RFI Work Plan for the preventative maintenance program for the ICP/MS and ICP.

11.3 INSPECTION/ACCEPTANCE REQUIREMENTS FOR SUPPLIES AND CONSUMABLES

Inspection/acceptance requirements for laboratory supplies and consumables are documented in Section 3.10, Attachment A of the RFI Work Plan.



12.0 SPECIFIC ROUTINE PROCEDURES USED TO EVALUATE DATA PRECISION, ACCURACY AND COMPLETENESS

The purpose of this section is to indicate the methods by which it will be ensured that the data collected for this investigation falls in line with the DQOs for the site.

Factors considered in this assessment include, but are not limited to:

- Possible future use of analytical results to conduct a groundwater specific Risk Assessment.
- The contaminants known and/or suspected to be of concern on a project as they relate to the data quality level parameters chosen.
- The choice of analytical and sample preparation methods for contaminants of concern whose method detection limits will meet or exceed the data quality level concentrations for those contaminants.

Once these goals and objectives are evaluated and chosen, analytical data quality will be assessed to determine if the objectives have been met. In addition, the data will be reviewed for indications of interferences to results caused by sample matrices, cross contamination during sampling, cross contamination in the laboratory, and sample preservation and storage anomalies (i.e., sample holding time).

12.1 ACCURACY ASSESSMENT

Accuracy will be calculated on the average percent recovery of spiked samples. In order to assure the accuracy of the analytical procedures, an environmental sample shall be spiked with a known



amount of the project target analytes. At a minimum, one spike sample shall be included in every set of 20 samples analyzed on each instrument. The increase in concentration of the analyte observed in the spiked sample, due to the addition of a known quantity of the analyte, compared to the reported value of the same analyte in the unspiked sample determines the percent recovery. Accuracy is similarly assessed through determination of percent recoveries for laboratory control samples. Reference materials are essential to the evaluation of accuracy. Stock solutions for accuracy spikes and laboratory control samples shall be traceable to a source independent from the calibration standards. Accuracy is calculated using the equation below:

$$\%R = \frac{SSR - SR}{SA \times 100} \quad \text{or} \quad \frac{SR}{TV} = 100$$

Where:

$\%R$ = percent recovery

SSR = spiked sample result

SR = sample result

SA = amount of spike

TV = true value (actual mass)

12.2 PRECISION ASSESSMENT

The precision of field duplicate pairs or laboratory duplicate pairs will be expressed as relative percent difference (RPD) or relative standard deviation (RSD). RPD is derived from the absolute difference between duplicate analyses divided by the mean value of duplicates. The percent RSD is obtained by dividing the standard deviation by the average of the sample set. Equations for RPD and RSD are presented below:



$$RPD = \frac{|D_1 - D_2|}{((D_1 + D_2)/2)} \times 100$$

Where:

D_1 and D_2 = two replicate values

$$RSD = \frac{S}{\bar{X}}; \text{ and } S = \left[\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{(n-1)} \right]^{1/2}$$

Where:

S = standard deviation

\bar{X} = average of sample set

x_i = each observed value

\bar{x} = the arithmetic mean of all observed values

n = total number of values

12.3 COMPLETENESS ASSESSMENT

Completeness is evaluated by dividing the total number of verifiable data points by the maximum number of data points possible and expressing the ratio as a percent. A usability criteria of 90 percent has been set for this project. Following completion of the analytical testing, the percent completeness will be calculated using the following equation:

$$\text{Completeness(\%)} = \frac{D}{P \times n} \times 100$$



Where:

D = number of confident quantifications

P = number of analytical parameters per sample requested for analysis

n = number of samples requested for analysis

12.4 ASSESSMENT OF DATA

The field and laboratory data collected during this investigation will be used to evaluate groundwater flow and quality and determine whether past drainage areas have been affected. The QC results associated with each analytical parameter will be compared to the objectives presented in Sections 3.5 and 3.6 of this QAPP. Only data generated in association with QC results meeting these objectives will be considered usable for decision making purposes.

In addition, the data obtained will be both qualitatively and quantitatively assessed on a project-wide, matrix-specific, parameter specific and unit-specific basis. The assessment will be performed by the QA Manager and the results will be presented and discussed in detail in the final investigation report. Factors to be considered in this assessment of the field and laboratory data will include, but not necessarily be limited to, the following:

- Were all samples collected using the methodologies and SOPs proposed in the QAPP?
- Were all proposed analyses performed in accordance with the SOPs provided in this QAPP?



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- Were samples obtained from all proposed sampling locations?
- Were samples received at the laboratory intact and within holding time requirements?
- Do any analytical results exhibit elevated detection limits due to matrix interferences or contaminants present at high concentrations?
- Were all data validated according to the validation documents proposed in this QAPP?
- Were any data found to be unusable (qualified as "R") based on the data validation results?
- Were any data found to be usable for limited purposes (qualified as "J") based on the data validation results?
- What affect due qualifiers applied as a result of data validation have on the ability to implement the project decision rules?
- Is data of sufficient quality to support possible future groundwater specific risk assessment?
- Can valid conclusions be drawn for each area under this investigation or is further sampling required?
- Were all issues requiring corrective action fully resolved?
- Based on the overall findings of the investigation and this assessment, were the original project objectives appropriately defined? If not, have revised project objectives been developed?



13.0 CORRECTIVE ACTION

When field sampling activities or laboratory quality control results show the need for corrective action, immediate action will take place and will be properly documented. In the event that a problem arises, corrective action will be implemented. Any error or problem will be corrected by an appropriate action which may include:

- Replacing or repairing a faulty measurement system;
- Discarding erroneous data;
- Collecting new data; and
- Accepting the data and acknowledging a level of uncertainty.

13.1 FIELD CORRECTIVE ACTION

The lead field sampler will be responsible for all field quality assurance. Any out of protocol occurrence discovered during field sampling will be documented in the field notebook and immediate corrective action will be taken. For problems or situations which cannot be solved through immediate corrective action, the lead field sampler will immediately notify the Contractor's Project Manager. The AGC Project Manager/QA Manager and lead field sampler will investigate the situation and determine who will be responsible for implementing the corrective action. Corrective action will be implemented upon approval by the AGC Project Manager/QA Manager. The AGC Project Manager/QA Manager will verify that the corrective action has been taken, appears effective, and at a later date, verify that the problem has been resolved. The successfully implemented corrective action will be documented in the field logbook by the lead field sampler. Any deviations from the quality assurance protocol in the QAPP must be justified, approved by the AGC Project Manager/QA Manager (and the IDEM, if necessary), and properly documented.



13.2 LABORATORY CORRECTIVE ACTION

Corrective action will be implemented to correct discrepancies found which affect the validity or quality of analytical data and to identify any analytical data that may have been affected. Limits of data acceptability for each parameter and sample matrix are addressed in the instrument manuals, USEPA Methods and/or Laboratory QA Manual (Attachment A). Whenever possible, immediate corrective action procedures will be employed. All analyst corrective actions are to be followed according to the instrument manuals, USEPA Methods, or Laboratory QA Manual. Any corrective action performed by analyst will be noted in laboratory logbooks.

Laboratory personnel noting a situation or problem which cannot be solved through immediate corrective action, will notify the Laboratory QA Supervisor. The QA Supervisor will investigate the extent of the problem and its effect on the analytical data generated while the deficiency existed. All data suspected to be affected will be scrutinized to determine the impact of the problem on the quality of the data. If it is determined that the deficiency had no impact on the data, this finding will be documented. If the quality of the analytical data were affected, the Laboratory Program Manager and Contractor's Project Manager will be notified immediately so that courses of action may be identified to determine how to rectify the situation.

The laboratory must take corrective action if any of the quality control data generated during the laboratory analyses are outside the method criteria. Corrective action for out-of-control calibrations is to recalibrate the instrument and reanalyze the samples. A sequence is specified in the USEPA specified methods when problems in analyses are encountered. The laboratory will follow these procedures exactly and document the problems encountered and corrective action in a case narrative enclosed with each data deliverables package.



The Laboratory QA Supervisor will be responsible for informing the Laboratory Program Manager and Sampling Contractor's Project Manager the effects on the data, the data affected and the corrective action taken. It is also the Laboratory QA Supervisor's responsibility to verify the corrective action was performed, appears effective, and at a later date, the problem was resolved.

Documentation of corrective actions taken by laboratory are outlined in Section 4, Attachment A of the RFI Work Plan. Reports will be completed to document nonconformances and the corrective actions taken. Copies of nonconformance reports will be included as part of the laboratory deliverable for this project.

13.3 CORRECTIVE ACTION DURING DATA VALIDATION AND DATA ASSESSMENT

Upon completion, sample data packages will be sent from the laboratory to the AGC QA Manager for data validation. If all project samples are not present in the data packages or any deficiencies affecting the sample results are noted, the QA Manager will contact the Laboratory Program Manager. The Laboratory Program Manager will consult with the Laboratory QA Supervisor and respond in writing to any inquiries and provide any changes to the data packages to the QA Manager. Any errors, problems, questionable data values, or data values outside established control limits will be corrected by the appropriate action which may include disregarding erroneous data, collecting new data, and accepting the data and acknowledging a level of uncertainty. The data validation report will provide a description of the usability of the data.



TABLES



TABLE 1-1
REFINED METALS SITE PROJECT ANALYTE LIST

Constituent	Matrix	Human Health Data Quality Level ¹	Ecological Data Quality Level ²	Quantitation Limit
Antimony	Aqueous	6 µg/L	NA	1 µg/L
Arsenic	Aqueous	0.045 µg/L*	NA	1 µg/L
Iron	Aqueous	11,000 µg/L	NA	100 µg/L
Lead	Aqueous	4 µg/L	NA	1 µg/L
Manganese	Aqueous	880 µg/L	NA	10 µg/L
Sodium	Aqueous	NA	NA	500 µg/L
Chloride	Aqueous	NA	NA	1 mg/L
Sulfate	Aqueous	NA	NA	5 mg/L

- * For these parameters, analytical sensitivity is inadequate to meet target decision levels. Therefore, for risk assessment purposes, non-detect data shall be considered as equal to one-half the reporting limit.

- 1 USEPA Region 9 Preliminary Remediation Goals (PRGs), 1998.
2 USEPA Region 5 Ecological Data Quality Levels.



**TABLE 3-1
REFINED METALS SITE
DATA QUALITY OBJECTIVES**

DQO Parameter	Laboratory Parameters	Field Parameters¹
Accuracy	Table 3-2	Table 3-2
Precision	Table 3-2	Table 3-2
Completeness	90%	100%
Comparability	Based on precision, accuracy, and media comparison	Based on precision, accuracy, and media comparison

Note

- 1 Indicator parameters include: specific conductance, temperature, dissolved oxygen, redox potential, and pH.



TABLE 3-2
REFINED METALS SITE
ACCURACY AND PRECISION DATA QUALITY OBJECTIVES FOR
LABORATORY AND FIELD PARAMETERS

Audit	Parameter	Analytes	Control Limits
Accuracy	Laboratory Blank	Metals Chloride Sulfate	< \pm LOQ
	Field/Equipment Blank	Metals Chloride Sulfate	< \pm LOQ
	Matrix Spike Recovery	Metals Chloride Sulfate	75-125 %, unless the sample concentration is greater than 4 times the amount of spike added
	Laboratory Control Sample	Metals Chloride Sulfate	80-120%
Precision	Matrix Spike	Metals Chloride Sulfate	<20% RPD for results > 5 x LOQ or < \pm LOQ for results < 5 x LOQ
	Field Duplicate	Metals Chloride Sulfate	<25% RPD for both results > 5 x LOQ, < \pm 1.5xLOQ for both results < 5 x LOQ, < \pm 1.5xLOQ for one result < 5 x LOQ and the other > 5 x LOQ
Accuracy/Precision Standard Checks	Field Parameters	pH Specific Conductance Turbidity Dissolved Oxygen Redox Potential Temperature	\pm 0.05 pH units \pm 10% RPD \pm 2% NTU \pm 0.3 mg/L \pm 0.1 mg/L \pm 0.2 °C

Note

LOQ Limit of Quantitation

Metals (Antimony, Arsenic, Iron, Lead, Manganese, Sodium)



TABLE 3-3
REFINED METALS SITE
SAMPLING AND ANALYSIS PROGRAM SUMMARY

Sample Location	Matrix	Parameters	Number of Samples ²	Field Duplicate	Matrix Spike	Blank ¹	Total Number of Samples ²
Monitoring Wells	Groundwater (rounds 1-4)	Field Turbidity pH Redox potential Specific conductance Temperature Dissolved Oxygen	12 ³	NA	NA	NA	12
		Laboratory Metals (Sb, As, Fe, Pb, Mn, Na)	4	1	1	2	8
		Chloride	4	1	1	2	8
		Sulfate	4	1	1	2	8
	Groundwater (all subsequent rounds)	Field Turbidity PH Redox potential Specific conductance Temperature Dissolved Oxygen	12 ³	NA	NA	NA	12
		Laboratory Metals (Sb, As, Pb)	4	1	1	2	8

Notes

- 1 Blank total includes estimated number of field and equipment blanks.
- 2 Total number of samples per event.
- 3 This number reflects the fewest number of samples to be taken.



TABLE 3-4
REFINED METALS SITE PROJECT ANALYTE LIST
QUANTITATION LIMITS

Parameters	Method ¹	Method Detection Limit	Quantitation Limit ²	Laboratory Standard Operating Procedure
Antimony	SW-846 3010A/6020	0.682 µg/L	1.0 µg/L	GR-01-121/GR-01-129
Arsenic	SW-846 3010A/6020	0.239 µg/L	1.0 µg/L	GR-01-121/GR-01-129
Iron	SW-846 3010A/6010	7.72 µg/L	100 µg/L	GR-01-121/GR-01-100
Lead	SW-846 3010A/6020	0.231 µg/L	1.0 µg/L	GR-01-121/GR-01-129
Manganese	SW-846 3010A/6020	0.845 µg/L	10 µg/L	GR-01-121/GR-01-129
Sodium	SW-846 3010A/6010	231 µg/L	500 µg/L	GR-01-121/GR-01-100
Chloride	MCAWW 325.2	0.386 mg/L	1.0 mg/L	GR-02-104
Sulfate	MCAWW 375.4	0.152 mg/L	5.0 mg/L	GR-05-108

Notes

- 1 Methods listed are from USEPA "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods" April 1998, SW-846, Fifth Edition and USEPA "Methods for Chemical Analysis of Water and Wastes" March 1983.
- 2 Specific quantitation limits are highly matrix-dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable.



**TABLE 4-1
REFINED METALS SITE
PARAMETER TABLE**

Parameter	Matrix	Method	Container Type	Preservative	Holding Time
Temperature, pH, Redox Potential, Dissolved Oxygen, Specific Conductance	Aqueous	Manufacturer's Instructions	NA	NA	Analyze Immediately
Antimony, Arsenic, Iron, Manganese ¹	Aqueous	USEPA SW-846 3010A/6020A ²	1 Liter HDPE	HNO ₃ to pH<2 Cool 4°C ± 2°C	180 Days
Lead, Sodium		USEPA SW-846 3010A/6010B ²			
Chloride	Aqueous	MCAWW 352.2 ³	1 Liter HDPE	Cool 4°C ± 2°C	28 Days
Sulfate	Aqueous	MCAWW 375.2 ³			28 Days

Notes

NA Not applicable

HDPE High density polyethylene plastic

HNO₃ Nitric acid

1 Includes total and dissolved metals. Dissolved metals will be field filtered prior to preservation.

2 USEPA "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods," April 1998, SW-846, Fifth Edition

3 USEPA "Methods for Chemical Analysis of Water and Wastes," March 1983



TABLE 6-1
SUMMARY OF LABORATORY CALIBRATION REQUIREMENTS

Method	Parameter	QC Check	Minimum Frequency	Acceptance Criteria
SW-846 6020A (ICP-MS)	Antimony, Arsenic, Lead, Manganese	Instrument Detection Limit (IDL) Determination	Every three months	SW-846 6020 Paragraph 8.2
		Internal Standards	Monitor during every analysis	Within $\pm 20\%$ of the original calibration solution
		Initial Calibration (minimum 1 standard and a blank)	Daily initial calibration prior to sample analysis	90-110% recovery for each parameter
		Calibration Verification (second source standard)	Before beginning a sample run, after every 10 samples and at the end of the analysis sequence	90-110% recovery for each parameter
		Instrument Blank (calibration blank)	Before beginning a sample run, after every 10 samples and at the end of the analysis sequence	No analyte detected \geq LOQ
		Method Blank (preparation blank)	One method blank for each group of 10 samples.	No analyte detected \geq LOQ
		Matrix Spike (MS)	One MS for each group of 10 samples.	75-125%
		Duplicate Sample Analysis	One duplicate for each group of 10 samples.	RPD $\leq 20\%$
		Laboratory Control Sample (LCS)	One LCS for each group of 10 samples.	80-120%
		Serial Dilution	One dilution test for each group of 20 samples.	Within $\pm 10\%$ of the original determination
		ICP Interference Check Solutions (ICS-A and ICS-AB)	Perform at the beginning of an analytical run or once every 12 hours, whichever is more frequent.	80-120%
		Post Digestion Spike	SW-846 6020 Paragraph 8.6	75-125%
		ICP Interelement Correction Factors	Annually	SW-846 6020 Paragraph 8.4
		MS Tuning Sample	Prior to calibration and analysis	95-105%
SW-846 6010B (ICP)	Iron, Sodium	Instrument Detection Limit (IDL) Determination	Quarterly	SOP GR-01-100, p.30
		Instrument Profile	Run before initial calibration	70-130% from the recorded value
		Instrument Calibration	Run before initial calibration	$r^2 \geq 0.995$
		Initial Calibration (minimum 1 standard and a blank)	Daily initial calibration prior to sample analysis	90-110% recovery for each parameter
		Calibration Verification (second source standard)	Before beginning a sample run, after every 10 samples and at the end of the analysis sequence	90-110% recovery for each parameter



Method	Parameter	QC Check	Minimum Frequency	Acceptance Criteria
		Instrument Blank (calibration blank)	Before beginning a sample run, after every 10 samples and at the end of the analysis sequence	No analyte detected \geq LOQ
		Method Blank (preparation blank)	One method blank for each group of 10 samples.	No analyte detected \geq LOQ
		Matrix Spike (MS)	One MS for each group of 20 samples.	75-125%
		Duplicate Sample Analysis	One duplicate for each group of 10 samples.	RPD \leq 10%
		Laboratory Control Sample (LCS)	One LCS for each group of 10 samples.	90-110%
		Serial Dilution	One dilution test for each group of 20 samples.	Within \pm 10% of the original determination
		ICP Interference Check Solutions (ICSA-1 and ICSA-2)	Perform at the beginning of an analytical run or once every 12 hours, whichever is more frequent.	80-120% spiked elements \pm 2*LOQ unspiked elements
		Contract Required Detection Limits (CRDL)	After initial calibration blank and before ICSA-1	80-120%
		Laboratory Fortified Blank (LFB)	One per sample batch.	75-125%
		Post Digestion Spike	One for each group of 20 samples.	80-120%
		ICP Interelement Correction Factors	Every six months	80-120%
MCAWW 325.2 MCAWW 375.2	Chloride Sulfate	Initial Calibration (minimum 6 standards and a blank)	Daily initial calibration prior to sample analysis	$r^2 \geq 0.9990$
		Calibration Verification (second source standard)	Before beginning a sample run, after every 10 samples and at the end of the analysis sequence	85-115% recovery for each parameter
		Instrument Blank (calibration blank)	Before beginning a sample run, after every 10 samples and at the end of the analysis sequence	No analyte detected \geq LOQ
		Method Blank (preparation blank)	One method blank for each group of 10 samples.	No analyte detected \geq LOQ
		Matrix Spike (MS)	One MS for each group of 10 samples.	70% - 125%
		Duplicate Sample Analysis	One duplicate for each group of 10 samples.	RPD \leq 20%
		Detection Limit Confirmation Sample (CRL)	One per run	80-120%
		Laboratory Control Sample (LCS)	One LCS for each group of 10 samples.	85% - 115%



TABLE 9-1
SUMMARY OF DATA VALIDATION REQUIREMENTS

Method	Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Qualifier Requirements
6020A	Antimony, Arsenic, Lead, Manganese	Instrument Detection Limit (IDL) Determination	Every three months	SW-846 6020 Paragraph 8.2	Apply R to all results for specific analyte(s) without a current IDL determination.
		Internal Standards	Monitor during every analysis	Within $\pm 20\%$ of the original calibration solution	Apply R to all results for specific analyte(s) not monitored for internal standards.
		Initial Calibration (minimum 1 standard and a blank)	Daily initial calibration prior to sample analysis	90-110 %R for each parameter	Apply R to all results for specific analyte(s) for all samples associated with the calibration if calibration not performed. If percent recovery (%R) is $<90\%$, apply J/UJ. If %R is $>110\%$, apply J. If %R is $<75\%$ or $>125\%$, apply R to all positive results.
		Calibration Verification (second source standard)	Before beginning a sample run, after every 10 samples and at the end of the analysis sequence	90-110 %R for each parameter	Apply R to all results for specific analyte(s) for all samples associated with the calibration if calibration not performed. If %R is $<90\%$, apply J/UJ. If %R is $>110\%$, apply J. If %R is $<75\%$ or $>125\%$, apply R to all positive results.
		Instrument Blank (calibration blank)	Before beginning a sample run, after every 10 samples and at the end of the analysis sequence	Not detected \geq LOQ	Apply R to all results for all analytes for all samples without an associated calibration blank. If sample concentration is $<5 \times$ blank concentration, result will be qualified U.
		Method Blank (preparation blank)	Analyze one method blank for each group of 10 samples.	Not detected \geq LOQ	Apply R to all results for specific analytes for all samples without an associated method blank. If sample concentration is $<10 \times$ blank concentration, result will be qualified U.
		Matrix Spike (MS)	Analyze one MS for each group of 10 samples.	75 – 125%	Professional judgement will be used to determine if associated sample data should be qualified when frequency is not met. If %R is $<75\%$, apply J/UJ. If %R is $>125\%$, apply J. If %R is $<30\%$, apply R to all results.



Method	Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Qualifier Requirements
		Duplicate Sample Analysis	One duplicate sample for each group of 20 samples.	If results >5X LOQ, RPD ≤ 20% If results <5X LOQ, ±LOQ value	Professional judgement will be used to determine if associated sample data should be qualified when frequency is not met. Apply J to all sample concentrations if acceptance criteria are not met.
		Laboratory Control Sample (LCS)	One LCS for each group of 10 samples or each batch, whichever is more frequent.	80 - 120%	Professional judgement will be used to determine if associated sample data should be qualified when frequency is not met. If %R is <80%, apply J/UJ. If %R is >120%, apply J. If %R is <50%, apply R to all results.
		Serial Dilution	One dilution test for each group of 20 samples.	Within ± 10% of the original determination	Professional judgement will be used to determine if associated sample data should be qualified when frequency is not met. Apply J to associated sample concentrations if acceptance criteria are not met and sample concentration is >50 * IDL.
		ICP Interference Check Solutions (ICS-A and ICS-AB)	At the beginning of an analytical run or once every 12 hours, whichever is more frequent.	80 - 120%	Professional judgement will be used to determine if associated sample data should be qualified when frequency is not met. If %R is <80%, apply J/UJ. If %R is >120%, apply J. If %R is <50%, apply R to all results.
		Post Digestion Spike	SW-846 6020 Paragraph 8.6	75 - 125%	Professional judgement will be used to determine if associated sample data should be qualified when frequency is not met. If %R is <75%, apply J/UJ. If %R is >125%, apply J. If %R is <30%, apply R to all results.
		MS Tuning Sample	Prior to calibration and analysis	SW-846 6020 paragraph 5.8	Apply R to all results for all analytes for all samples associated with the MS tuning.
		Holding Time Specifications.	NA	180 days from sample collection to analysis	Apply J/UJ to all samples analyzed after holding time has elapsed. Professional judgement will be used to determine if associated sample data should be rejected when holding time is grossly exceeded.

Method	Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Qualifier Requirements
6010B	Iron, Sodium	Field Duplicate Analysis	1 per 10 samples collected	If results $>5*LOQ$, $RPD \leq 25\%$ If results $<5*LOQ$, $\pm 1.5*LOQ$ value	Professional judgement will be used to determine if associated sample data should be qualified when frequency is not met. Apply J to all sample concentrations if acceptance criteria are not met.
		IDL Determination	Every three months	SW-846 6020 Paragraph 8.2	Apply R to all results for specific analyte(s) without a current IDL determination.
		Instrument Detection Limit (IDL) Determination	Every three months	SOP GR-01-100, p.30	Apply R to all results for specific analyte(s) without a current IDL determination.
		Internal Standards	Monitor during every analysis	Within $\pm 20\%$ of the original calibration solution	Apply R to all results for specific analyte(s) not monitored for internal standards.
		Initial Calibration (minimum 1 standard and a blank)	Daily initial calibration prior to sample analysis	90-110 %R for each parameter	Apply R to all results for specific analyte(s) for all samples associated with the calibration if calibration not performed. If percent recovery (%R) is $<90\%$, apply J/UJ. If %R is $>110\%$, apply J. If %R is $<75\%$ or $>125\%$, apply R to all positive results.
		Calibration Verification (second source standard)	Before beginning a sample run, after every 10 samples and at the end of the analysis sequence	90-110 %R for each parameter	Apply R to all results for specific analyte(s) for all samples associated with the calibration if calibration not performed. If %R is $<90\%$, apply J/UJ. If %R is $>110\%$, apply J. If %R is $<75\%$ or $>125\%$, apply R to all positive results.
		Instrument Blank (calibration blank)	Before beginning a sample run, after every 10 samples and at the end of the analysis sequence	Not detected $\geq LOQ$	Apply R to all results for all analytes for all samples without an associated calibration blank. If sample concentration is $<5 * \text{blank concentration}$, result will be qualified U.
		Method Blank (preparation blank)	Analyze one method blank for each group of 10 samples.	Not detected $\geq LOQ$	Apply R to all results for specific analytes for all samples without an associated method blank. If sample concentration is $<10 * \text{blank concentration}$, result will be qualified U.



Method	Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Qualifier Requirements
		Matrix Spike (MS)	Analyze one MS for each group of 10 samples.	75 - 125%	Professional judgement will be used to determine if associated sample data should be qualified when frequency is not met. If %R is <75%, apply J/UJ. If %R is >125%, apply J. If %R is <30%, apply R to all results.
		Duplicate Sample Analysis	One duplicate sample for each group of 20 samples.	If results >5X LOQ, RPD ≤ 20% If results <5X LOQ, ±LOQ value	Professional judgement will be used to determine if associated sample data should be qualified when frequency is not met. Apply J to all sample concentrations if acceptance criteria are not met.
		Laboratory Control Sample (LCS)	One LCS for each group of 10 samples or each batch, whichever is more frequent.	80 - 120%	Professional judgement will be used to determine if associated sample data should be qualified when frequency is not met. If %R is <80%, apply J/UJ. If %R is >120%, apply J. If %R is <50%, apply R to all results.
		Serial Dilution	One dilution test for each group of 20 samples.	Within ± 10% of the original determination	Professional judgement will be used to determine if associated sample data should be qualified when frequency is not met. Apply J to associated sample concentrations if acceptance criteria are not met and sample concentration is >50 * IDL.
		ICP Interference Check Solutions (ICSA-1 and ICSA-2)	At the beginning of an analytical run or once every 12 hours, whichever is more frequent.	80 - 120%	Professional judgement will be used to determine if associated sample data should be qualified when frequency is not met. If %R is <80%, apply J/UJ. If %R is >120%, apply J. If %R is <50%, apply R to all results.
		Post Digestion Spike	SW-846 6020 Paragraph 8.6	75 - 125%	Professional judgement will be used to determine if associated sample data should be qualified when frequency is not met. If %R is <75%, apply J/UJ. If %R is >125%, apply J. If %R is <30%, apply R to all results.
		Holding Time Specifications	NA	180 days from sample collection to analysis	Apply J/UJ to all samples analyzed after holding time has elapsed. Professional judgement will be used to determine if associated sample data should be rejected when holding time is grossly exceeded.



Method	Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Qualifier Requirements
		Field Duplicate Analysis	1 per 10 samples collected	If results $>5*LOQ$, $RPD \leq 25\%$ If results $<5*LOQ$, $\pm 1.5*LOQ$ value	Professional judgement will be used to determine if associated sample data should be qualified when frequency is not met. Apply J to all sample concentrations if acceptance criteria are not met.
		IDL Determination	Every three months	SW-846 6020 Paragraph 8.2	Apply R to all results for specific analyte(s) without a current IDL determination.
325.2 375.2	Chloride Sulfate	Initial Calibration (minimum 1 standard and a blank)	Daily initial calibration prior to sample analysis	≥ 0.0990	Apply R to all results for specific analyte(s) for all samples associated with the calibration if calibration not performed. If correlation coefficient is < 0.0990 , apply J/R.
		Calibration Verification (second source standard)	Before beginning a sample run, after every 10 samples and at the end of the analysis sequence	85-115%R for each parameter	Apply R to all results for specific analyte(s) for all samples associated with the calibration if calibration not performed. If %R is $<90\%$, apply J/UJ. If %R is $>110\%$, apply J. If %R is $<75\%$ or $>125\%$, apply R to all positive results.
		Instrument Blank (calibration blank)	Before beginning a sample run, after every 10 samples and at the end of the analysis sequence	Not detected $\geq LOQ$	Apply R to all results for all analytes for all samples without an associated calibration blank. If sample concentration is less than 5 times the blank concentration, result will be qualified U.
		Method Blank (preparation blank)	One method blank for each group of 10 samples.	Not detected $\geq LOQ$	Apply R to all results for specific analytes for all samples without an associated method blank. If sample concentration is $<10 * \text{blank concentration}$, result will be qualified U.
		MS	One MS for each group of 10 samples.	75 – 125%	Professional judgement will be used to determine if associated sample data should be qualified when frequency is not met. If %R is $<75\%$, apply J/UJ. If %R is $>125\%$, apply J. If %R is $<30\%$, apply R to all results.
		Duplicate Sample Analysis	One duplicate for each group of 20 samples.	If results $>5*LOQ$, $RPD \leq 20\%$ If results $<5*LOQ$, $\pm LOQ$ value	Professional judgement will be used to determine if associated sample data should be qualified when frequency is not met. Apply J to all sample concentrations if acceptance criteria are not met.



Method	Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Qualifier Requirements
		LCS	One LCS for each group of 10 samples or each batch, whichever is more frequent.	85-115%	Professional judgement will be used to determine if associated sample data should be qualified when frequency is not met. If %R is <80%, apply J/UJ. If %R is >120%, apply J. If %R is <50%, apply R to all results.
		Holding Time Specifications	NA	28 days from sample collection to analysis	Apply J/UJ to all samples analyzed after holding time has elapsed. Professional judgement will be used to determine if associated sample data should be rejected when holding time is grossly exceeded.
		Field Duplicate Analysis	1 per 10 samples collected	If results >5*LOQ, RPD ≤ 25% If results <5*LOQ, ±1.5 X LOQ value	Professional judgement will be used to determine if associated sample data should be qualified when frequency is not met. Apply J to all sample concentrations if acceptance criteria are not met.

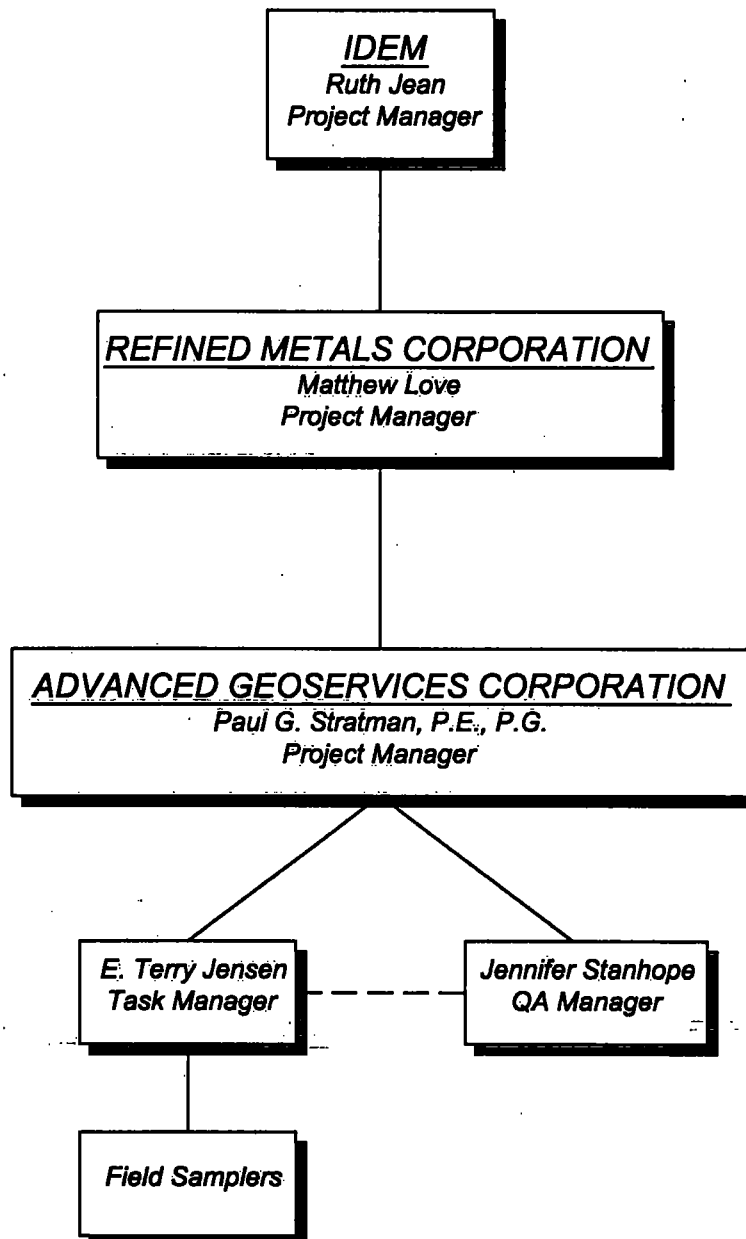


TABLE 11-1
REFINED METALS SITE
PREVENTATIVE MAINTENANCE PROCEDURES
SCHEDULE AND SPARE PARTS LIST


Instrument	Activity	Frequency	Spare Parts
ICP-MS	Change peristaltic tubing	Every 8 hours	Tubing
	Change gas and instrument filters	As needed	Filters
	Check to make sure the gas supply is sufficient for day's activities	Daily	Gases
	Clean nebulizer	Daily	
Hot plates	Monitor temperature	Daily	
Ovens	Monitor temperature	Daily	
Refrigerators	Monitor temperature	Daily	
pH meter	Calibrate with two standard solutions	Daily, throughout day	pH buffers
	Replace electrodes	As needed	Electrodes
Conductivity Meters	Calibrate	Daily	
	Check batteries	Daily	Batteries
Thermometer	Check against calibrated thermometer	Yearly	



FIGURES



REFINED METALS CORPORATION
BEECH GROVE, INDIANA

Scale:	PROJECT ORGANIZATION CHART
Originated By:	
Drawn By: P.S.G.	
Checked By: P.G.S.	
Project Mgr: P.G.S.	
Dwg. No. 2003-1046-05-01	 Advanced GeoServices Corp. 1055 Andrew Drive, Suite A West Chester, Pennsylvania 19380 (610) 840-9100 FAX: (610) 840-9199
AUG 16 2004 Project No. 2003-1046-05	
FIGURE: 2-1	

